CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

BULLETIN 48

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FROM ALBERTA

By Wayne L. Fry and D. J. McLaren

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SYNAPTOPHYLLUM SIMPSON

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Price, $1.00

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PREFACE

The first of the three papers comprising this bulletin describes some peculiar filaments found in specimens of Devonian limestone. Fungal origin of the filaments is established and evidence favouring a Devonian age is compared with evidence for a modern age.

The second paper is an account of an occurrence of petrified logs. The wood is described and identified as belonging to a genus of tree that lived during the late Mesozoic and Tertiary, being particularly abundant in the latter. The sediments containing the wood had been dated as Triassic, but this is shown to be most unlikely and a later age is suggested.

The final paper is the revision of a coral genus, the interpretation of which has long been in a state of great confusion. As a result of this study all but one of the species ascribed to it were found to differ so markedly from the type species that a new generic name is proposed for them. Also ascribed to the original genus were several specimens that do not belong to the genus studied and differ even from the species in which they have been placed. For these the author proposes new names and a different generic affiliation.

J. M. HARRISON,
Director, Geological Survey of Canada

OTTAWA, January 15, 1958

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FUNGAL FILAMENTS IN A DEVONIAN LIMESTONE FROM ALBERTA

Introduction

By Wayne L. Fry and D. J. McLaren

During routine examination of limestone samples from Devonian outcrops in the Alberta Front Ranges small chips of rock were dissolved in dilute hydrochloric acid in order to determine the proportion and composition of insoluble residues. One specimen was observed to yield an unusual residue, consisting of a felty mass that retained the shape of the original chip. This mass was found to be organic and was made up of large quantities of intertwined and anastomosed thread-like filaments. These remains were obtained from a limestone in the Upper Flume formation near Job Creek, Alberta. The presence of similar filamentous organic remains in residues from graptolite-bearing nodules of Llandoverian age from the Cape Phillips formation on Cornwallis Island, Queen Elizabeth Islands was drawn to our attention by R. Thorsteinsson of the Geological Survey of Canada, to whom we are indebted. The apparent absence of published reference to filaments of this nature in insoluble residues of rocks on such a scale prompted a more thorough and extensive study.

Large concentrations of filamentous organic material in Silurian and Devonian sediments pose several interesting problems. For example, it is of considerable importance to determine whether the filamentous organisms lived or were buried in the sediments at the time of their accumulation, or alternatively if the organisms grew into the rock by solution penetration during more recent time. The question of the botanical affinity of the filaments is of interest in that it relates to the possible presence of an organism of low organization in Palæozoic sediments. On the other hand, if the filaments are of relatively recent origin their remarkable power to penetrate non-porous rock should be recorded.

The filaments were discovered in a routine rock sample collected by McLaren in 1953. The same outcrop was visited the following year by P. Harker of the Geological Survey of Canada and J. L. Usher of Queen's University who kindly collected additional material.

Samples of the filaments were sent to Harold C. Bold of Vanderbilt University, G. W. Prescott of Michigan State College, G. M. Smith, Emeritus Professor of Biology, Stanford University, and W. R. Taylor of the University of Michigan, who kindly offered their opinions on the affinities of the material.

Geological Setting

The limestone specimens yielding the filaments described in this paper were collected from an outcrop on the east side of the trail leading down into Job Creek from Coral Creek and Job Creek Pass, about 29 miles westsouthwest of Nordegg, in the Front Ranges of the Alberta Rocky Mountains (lat. 52° 21', long. 116° 43'). The outcrop is approached up the stream that joins Job Creek from the southeast about a mile downstream from the foot of the Pass.

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The section in which the limestone occurs was described by McLaren (1956, pp. 54-59)[1]. This limestone forms part of unit 10 of that report, the unit comprising the highest beds of the upper member of the Devonian Flume formation. The unit was described as:

"Limestone, dark brownish grey, very fine-grained; thick-bedded; finely colour banded ($\frac{1}{2}$ to $1\frac{1}{2}$ mm.); insoluble residue consists of a mass of very fine, anastomosing filaments; scattered small crystals of fluorite . . . 9 feet."

The base of the unit is 196 feet above the base of the Flume formation, which overlies rocks of probable Ordovician age with slight unconformity; the formation is 205 feet thick.

Unit 10 is underlain by black, slightly argillaceous, fine-grained limestone, interbedded with black calcareous shale containing *Nudirostra athabascensis* (Kindle), *Eleutherokomma* spp. cf. *E. jasperensis* (Warren) and *E. leducensis* Crickmay. This is a normal upper Flume fauna of early Late Devonian age. Overlying the unit under consideration is a black argillaceous limestone unit, medium bedded, with thin calcareous mudstone bands. A fauna similar to that listed above occurs 4 feet from the base of this unit and, 36 feet higher, *Nudirostra insculpta* McLaren, *Tentaculites* and small pelecypods are abundant. These beds are assigned to the Perdrix formation and are also Late Devonian in age.

The filaments, therefore, occur in a limestone that forms part of a normal marine sequence of Upper Devonian rocks. The lithologies and faunas of the overlying and underlying beds indicate deposition in moderately deep water, at least below the level of strong wave action, with little or no oxidation of bottom sediments. The horizon is a little above the base of a widespread cycle of mud deposition. In the vicinity, at an unknown distance owing to subsequent thrusting, carbonate banks, largely biostromal and reefoid, were being formed at this time above the level of the areas of mud deposition. These banks supplied quantities of fine calcite mud that was washed into the mud 'basins' giving rise to calcareous shales in some areas and fine-grained argillaceous limestones in others.

The limestone under discussion is distinctive in the field owing to its extremely fine grain, thick bedding, fine banding, and total lack of megafossils. A similar unit was recorded in a similar stratigraphic position at the top of the Flume formation 14 miles along strike to the southeast, in the same fault block, on the mountain side 2 miles northwest of the confluence of the Cline and North Saskatchewan Rivers. Field samples were not taken at this locality.

Lithology

In thin section under high magnification the limestone is seen to be extremely fine grained and composed of a closely knit mass of calcite grains that can scarcely be distinguished owing to their high refraction and overlapping edges (Plate I). Where the edge of a thin section has disintegrated the individual grains separate easily and may be examined and measured (Plate I, figure 4). The grains are elongate, their lengths varying between 3μ and 18μ with an average of about 7μ. The width varies between a half and a quarter of the length. Between the disintegrated grains a cer-

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[1] Dates in parentheses are those of references cited at the end of this part of the bulletin.

tain amount of finer calcite particles was observed with diameters less than .5 μ. These may be the result of breaking of the grains when the section was disintegrated.

Most of the grains are highly irregular, although their sides tend to be approximately parallel and the ends roughly pyramidal. A few grains appear to have plane faces and more rarely approach the form of an elongate bi-pyramid.

Some sections show the development of scattered authigenic fluorite crystals between 20 and 35 μ across (Plate I, figure 3). They are square in outline, and enclose variable amounts of calcite grains similar to those described above.

Under low magnification, sections cut at right angles to the bedding show fine colour banding with 4 to 8 bands to one millimetre (Plate I, figure 1). These bands are a primary depositional feature and exhibit small-scale sedimentary structures including slight rippling, micro-unconformities, and wash-outs. Microstylolites are abundant parallel to the bedding, and the rock is traversed by numerous steeply inclined veinlets of calcite, only slightly coarser grained than the rock matrix. Some of the veinlets are displaced where they cross stylolites, others cut the stylolites without interruption, indicating that some originated before and some after the period of stylolite formation.

Specimens of limestone in which fine banding is well developed yielded the greatest bulk of filaments on solution in acid. Other specimens that yielded little or no filament material showed coarser banding in section and incipient recrystallization, producing a rock with a typical grumous or clotted texture (Plate I, figure 2).

In every specimen examined the rock was remarkably dense and possessed no porosity whatsoever, nor was there the slightest indication or sign of filaments in thin sections. Sections were prepared that were searched for filaments without result. When one of these sections was subsequently dissolved off the glass slide, fragments of filaments were to be seen adhering to the balsam cement.

On solution in weak acid the rock yielded, in addition to various amounts of filaments, small quantities of clay minerals, crystals of fluorite as described previously, and black carbonaceous material. The clay minerals tend to adhere to the filamentous mass and, by their occurrence in bands, indicate that the banding seen in thin section is due to various proportions of clay (Plate II, figure 2). There is no indication of variation in grain size.

A limited chemical analysis of a fragment of rock shown to be rich in filaments was performed by John A. Maxwell of the Geological Survey of Canada and showed the following proportions:

CaO	55.13
MgO	0.39
CO_2	43.62
insoluble matter	0.61
R_2O_3	0.16
organic matter	0.20
	100.11

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The purity of the limestone is noteworthy. The organic matter represents carbon not in combination as carbonate and some of it is presumably organic carbon in the filaments. Free carbon is also present in small amounts; R. W. Boyle of the Geological Survey of Canada stated that it is too finely divided to yield an X-ray pattern for graphite and is presumably in the form of amorphous carbon.

Materials and Techniques

All of the filaments studied were obtained from an assorted collection of limestone samples obtained at the locality. These rock specimens ranged up to 6 inches minimum dimension. Chips and small cubes were taken from the surfaces of the limestone samples and at various depths within rock specimens, up to a maximum of nearly 3 inches from any surface.

All sample chips and cubes were placed in 5 or 10 per cent hydrochloric acid and left there until the rock was completely dissolved.

The filaments were removed from the acid, gently washed in tap water, and stored and studied either in that medium or in glycerine. Microscopic examination of the filaments was carried out by removing small bits of the filamentous mat and placing them on a glass slide. Separation of the filamentous aggregations by gently pulling them apart aided the study of detail under higher magnifications. The specimens were covered and studied under various magnifications up to 1,500 diameters.

The use of assorted stains and dyes did little to improve the morphological details observable using transmitted light of various intensities through assorted filters.

Description of Plant Remains

The gross appearance of the organic remains when released from the rock matrix, some from as much as nearly 3 inches below the surface, was that of a dark grey to blackish mat (Plate II, figure 1). The apparent dark colour was due in part to clay mineral particles adhering to the matted plant debris. Magnification showed the mat to consist of a mass of small, tangled and anastomosed filaments of two different sizes (Plate II, figure 3). The smaller filaments average 1.6 μ in diameter and the larger rarer strands 3.3 μ. Deviation of individual filaments from the average was less than 10 per cent, illustrating a remarkable uniformity in diameter for both sizes.

The length of individual filaments is difficult to determine. However, a reasonable estimate would probably be 4 to 5 centimetres. It is of particular interest to find that there is practically no gradation between the two strand sizes and that the larger is almost double the size of the smaller. This would seem to indicate two separate organisms. The rare, larger filaments are a slightly darker brown than the small strands. However, this may be related to the density and thickness of the wall substance producing a deeper shade. The bulk of the plant material is made up of the smaller filaments with the larger ones occurring sparingly.

Both filament types are characterized by a uniform size throughout their length and have not been found to taper. Transverse septations occur but are infrequent. However, wherever a branch occurs it will usually be

set off by cross-walls (Plate III, figures 2, 3). The branching of the fila-ments is infrequent but when it occurs the branch filaments tend to grow at right angles from the parent strand (Plate III, figures 1, 3, 4).

The external surface of the walls of the filaments appears to be smooth and without markings or ornamentation of any kind. The thicknesses of the walls of both filaments average approximately a quarter of the diameter. Neither size form has walls that thicken or thin regularly or irregularly. Bulbous or knot-like structures resulting from excess local growth or con-strictions in the filament were nowhere observed.

The filaments are optically isotropic.

Affinities of the Filaments

The description of living organisms is usually based on a wide array of characters. For these filaments, however, we are limited to the follow-ing morphological characters: 1) shape; 2) size; 3) mode of branching; and 4) cellular division. We can in addition make some inferences concerning their habitat by studying the conditions of deposition of the mud and the present outcrops of rock.

The most superficial examination of the specimens eliminates any vas-cular plant from consideration. There remain only two possible groups of plants to which the organisms represented by these filaments could belong, namely, the algae and fungi.

The bizarre alga *Prototaxites* with an internal structure composed of a mass of intertwined small tubes aggregated and oriented vertically into trunk-like organs suggests a certain basis for comparison. The larger, tube-like structures of *Prototaxites logani*, for example, have a diameter range of 13 to 35 μ while the smaller ones are 5 to 6 μ (Arnold, 1947). Other species of *Prototaxites*, however, have uniform or intergrading tube sizes. Filaments isolated from the Alberta limestone are without orientation, of a different size, branch, and are septate. These distinctive features all seem effectively to eliminate any consideration of similarity between *Prototax-ites* and the filamentous mats described here.

Algal filaments in general are commonly somewhat coarser than the fine threads of fungal hyphae such as are typified by the organism described above. Most filamentous algal forms have a uniform taper, whereas the filaments described above do not illustrate this character in any way. Rare cross-walls, the habit of branching, and general wall characteristics all in-dicate fungi. Perhaps the most fungus-like feature is the abundance of anastomoses and fusions between hyphae. Suggestions of conidia develop-ment have been noted but are rare. These facts support the unanimous opinion of a number of botanical specialists who were consulted and who examined the material. Selected quotations from their letters illustrate the unanimity. Harold C. Bold, "I feel quite strongly that the material repre-sents the mycelium of a fungus". G. W. Prescott notes that the "material is without doubt at all fungal. The character of the walls, the habit of branching and cross septations are clearly fungal." G. M. Smith, "I feel very certain that the material is fungus in nature rather than algal". W. R. Taylor indicates that "it is probably fungal, quite possibly some Phyco-

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mycete . . . I do not see anything algal about it, the asymmetry of the filaments and their small size, scanty formation of cross walls, etc., are of a fungal rather than algal aspect."

In general, the fungal characters exhibited by the filaments under discussion may be summarized as follows:

1. Extremely small size of the filaments.
2. Irregularly attenuate and non-tapering forms of the hyphae.
3. Presence of anastomoses and fusions between hyphal strands.
4. Scarcity of septations.
5. Right-angle habit of hyphal branch formation.

Thus there seems to be little doubt that the organisms represented by these hyphae are fungal and are probably phycomycetous.

Fossil or Recent?

Although the filaments described here occur in solid rock and are released only by solution of the rock, nevertheless the possibility cannot lightly be dismissed that they are of recent rather than fossil origin.

There are numerous general literature references to filaments penetrating rock, most of which are concerned with endolithic lichens. However, since the algal part of a lichen must utilize light as its source of energy, part of the plant thallus would of necessity be exposed on the surface of the rocks. No evidence of this kind was observed on the specimens studied.

A common substratum for lichens is limestone, a part of the plant vegetative body being immersed in the rock. The burrowing is accomplished by a solution process in that the filaments excrete a substance that eventually breaks down the rock structure. However, according to certain detailed studies (Smith, 1921) the tissues or filaments are usually visible without magnification and are zoned. The outermost layer is termed 'cortical hyphae' and it is in turn underlain by a gonidial zone. The innermost region consists of interlaced tissue of various kinds. In the present study nothing of this complex arrangement of the plectenyma has been observed. Furthermore, if the fungal filaments are the symbiont of an alga then the resulting lichen should contain some evidence of the algae in the form of clasping hyphae in and around the algal gonidia. These relationships should have appeared in our outcrop samples if they existed, but they were nowhere observed.

Lichens penetrate by a solution process with the fungal component carrying the thallus into the rock associated with its algal partner. The filaments can, by solution, break up or penetrate calcite crystal to depth of 200 to 350 μ. Algal components are then said to occupy the pore spaces. Friederich (1906) records a gonidial algal zone 600 to 700 μ thick with some hyphal components reaching a depth of 12 to 30 mm.

Lichens have also been recorded penetrating granitic, volcanic and slaty rocks.

It would appear from the foregoing evidence that lichen penetration is not known to occur to the maximum of nearly 70 mm. recorded in this investigation.

In lichen associations the fungus is the predominating partner and, in all but a few tropical lichens, belongs to the Ascomycetes. In the tropical (Hymenolichens) the fungi are Basidiomycetes.

The fungal nature of the filaments appears to be well established, but it should be emphasized that no proof is forthcoming in support of either a fossil or a recent origin. The following points are offered in an attempt to draw a reasonable conclusion from the assembled evidence.

(1) The depth of penetration of the filaments into the rock has been shown to be a maximum of nearly 3 inches from any weathered surface or from any fracture or weakness within the body of the limestone. This far exceeds the 30 mm. figure cited by Friederich (1906).

(2) The grain size of the rock ranging from 3 to 7 μ, is comparable with the size of the filaments, which are between 1.6 and 3.3 μ in diameter. The rock is non-porous and no sign of filaments is discernible in thin section. These two facts make it difficult to visualize how a recent fungus could have penetrated deeply and in such quantity into so dense a medium without any traceable solution effects.

(3) Although there are abundant veinlets traversing the rock they are all filled with fine-grained, dense secondary calcite and some of them are displaced by microstylolites. This suggests an early origin of the veinlets and there is no doubt that the veinlets antedate exposure of the rock to surface erosion, and hence no fracture system is available for entry of recent fungal growth.

(4) The outcrop of the rock is on a steep mountainside. Softer beds occur immediately above and below, and angular talus is being supplied continuously from the outcrop surface. The unit, and indeed the complete section of Devonian rocks, is undergoing rapid erosion. This is far from being a favourable situation for the growth of lichen or some organism that is either fungal or contains fungi symbiotically.

(5) Under the hypothesis of a recent origin, a lichen is the most probable source for the hyphae. Some sign of symbiotic algae would then be expected in the material, especially in specimens from close to an external surface of rock; none was seen. The opinion of experts, already acknowledged, is that the filaments are hyphae of a phycomycete, a group that does not form symbiotic assemblages with algae as lichens.

Ecology

In the above discussion on whether the filaments are fossil or recent we have examined the evidence. This plainly suggests that they are of fossil origin. It is proposed, however, in this final and entirely speculative section to examine possible ecological conclusions that may be drawn assuming the filaments to be of (a) fossil and (b) recent origin.

(a) *If the filaments are fossil in origin.*

Harold C. Bold stated in a letter concerning the filaments that "if they are fungi, they should have been growing in some organic substratum . . . It is hard to think of a free-living fungus under such circumstances." At any given moment during deposition the fungus may be pictured as growing on the surface of the soft mud and possibly penetrating into it, only to be smothered and preserved as a fresh influx of mud arrived on the bottom

to be penetrated in turn by another growth. The presence of abundant organic matter in the mud is evidenced by the high total non-carbonate carbon content of the rock on analysis, part of this being present as amorphous carbon. R. W. Boyle of the Geological Survey of Canada has pointed out that the presence of authigenic fluorite is a further indication of organic matter in the rock at time of deposition, the only feasible origin of the fluorine being organic.

A study of the regional setting of the rock suggests an environment on the sea floor during the formation of the filament-bearing limestone. The mud was nearly pure calcite; the amount of terrigenous clastics entering the area was small. Variations in quantity of non-calcite mud produced fine banding of the sediment and slight currents produced small irregularities of these bands. There were no scavengers or any macrofauna living on the bottom—the sedimentary banding is undisturbed and there are no fossils. Oxidizing conditions were at a minimum, organic matter was not broken down rapidly. This matter was being deposited simultaneously with the muds. The calcite grains may represent a primary organic precipitate in situ, but this is not considered probable. The water depth was greater than over nearby biostromal banks where a more favourable precipitating environment was probable.

It is an attractive possibility that the calcite mud and organic material may have a common origin. By analogy with present-day conditions in warm shallow seas, weakly calcified algae may have flourished on and around the borders of carbonate banks of the Devonian seas in Alberta. These algae may have contributed both the calcite grains and their soft parts, washed into the deeper mud basins before total destruction by active scavengers in the shallow waters. Lowenstam (1955) has recently shown that certain algae make important contributions of aragonite needles to modern carbonate sediments. These needles would soon be converted to calcite, probably before total lithification. The partly disintegrated algal tissues contained within the mud would furnish a sufficient organic substratum in which fungi might grow. Deposition was probably slow and compaction gentle; the filaments are long and unbroken and were presumably squeezed between the grains of the rock when compacted, without being ruptured.

The above suggestions on the environment of deposition hold good whether fungi were present on the sea bottom or not. Organic content of the sediment is evidenced by the presence of carbon in the rock.

(b) If the filaments are recent in origin.

Rock-penetrating plants are commonly the fungal part of lichens. However, the filaments described above do not resemble known fungal ascomycetous symbionts of lichens and appear phycomycetous in character. An alternative is to suggest that these filaments form the symbiont with an alga in an unusual lichen.

If these filaments are indeed part of a lichen, they must have possessed an unusual rate of growth. The filaments were found in rocks on a steep hillside undergoing rapid erosion, not a favourable environment for the development of slow-growing organisms.

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If the organisms are not part of lichens they must nevertheless possess remarkable "boring" ability to be able to penetrate into dense, fine-grained limestone for a minimum of nearly 3 inches. It must also be assumed that they obtain their energy from an unknown and unrecognized constituent in the sediment.

The presence of two sizes indicates either a dimorphic organism or the natural association of two organisms in a very unusual ecological niche.

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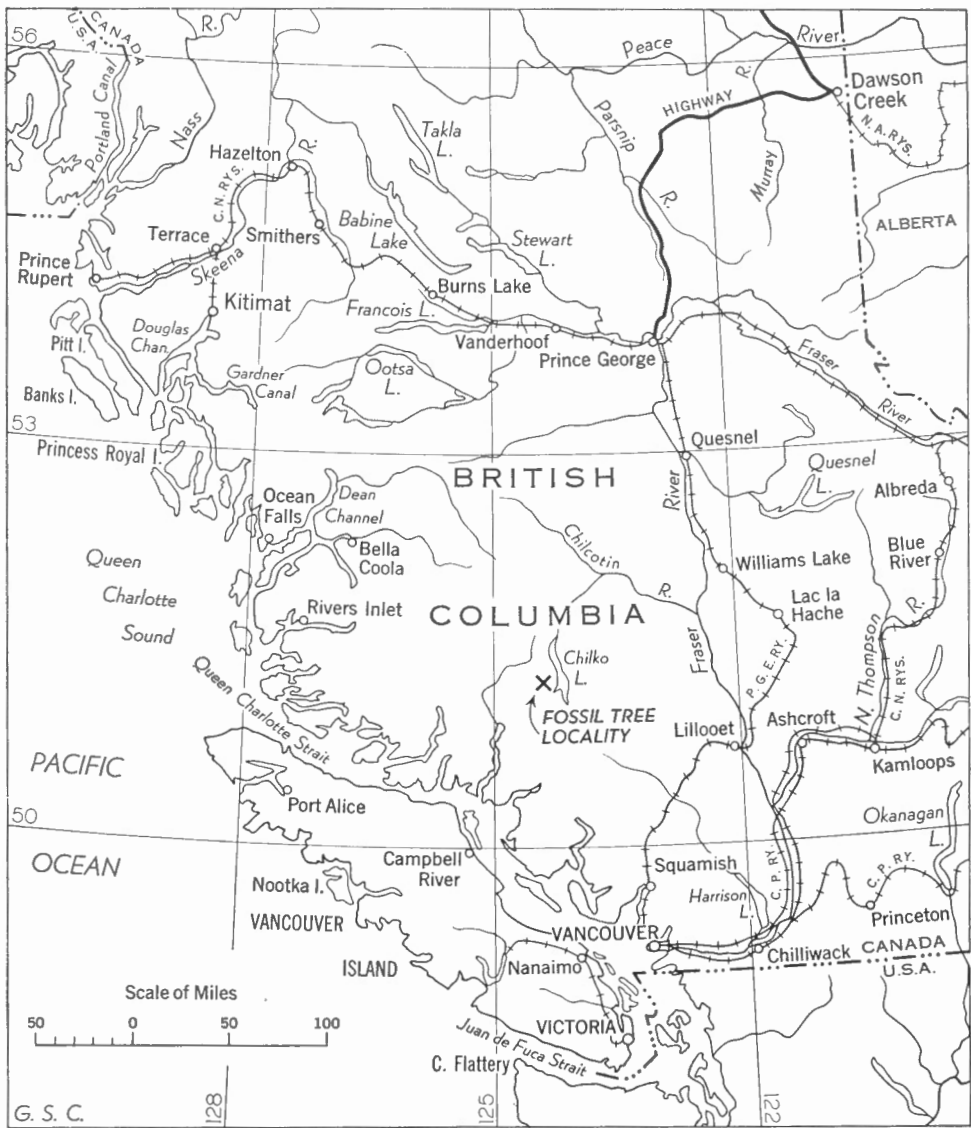
Text-figure 1. Index map of British Columbia showing position of petrified wood locality.

PETRIFIED LOGS OF *CUPRESSINOXYLON* FROM THE WEST SHORE OF CHILKO LAKE, BRITISH COLUMBIA

By Wayne L. Fry

Introduction

Occurrences of petrified logs are always somewhat spectacular and tend to attract attention. This proved to be the case during the summer of 1946 when Ferdie Brent, G. H. Lee and H. V. Warren discovered petrified logs while returning from a prospecting traverse along the west shore of Chilko Lake. They collected a few hand specimens, some of which were sent to the Geological Survey of Canada. W. A. Bell examined the specimens and agreed that the locality was worthy of further investigation. Through the continued interest of H. V. Warren of the University of British Columbia the matter was again brought to the attention of the Geological Survey. During the field season of 1954 Charles B. Beck, G. H. Lee and the writer made an unsuccessful attempt to relocate the area. In the summer of 1955, in company with G. H. Lee, H. V. Warren, and Colin McGregor, the locality was found. Extensive collections were brought out and related field data were taken.

Geographic Location

The locality is awkward to reach. One route is to fly from Kamloops, B.C., to the north end of Chilko Lake and land on the river near Chilko Lodge (*see* Figure 1). Boats can be rented at Chilko Lodge, and during periods of moderate to low velocity winds it is possible to travel down the lake for about 37 miles to a point on the west shore within walking distance of the fossil tree locality. Another method of reaching the north end of Chilko Lake is via the road that leaves the Williams Lake—Bella Coola highway at a point 12 miles west of Alexis Creek, B.C. The 55 miles of road from Alexis Creek to the Lodge are rough and passable only during dry weather.

The place to land on the west shore near the locality is directly opposite the broad delta of Rainbow Creek on the east shore of the lake. An important landmark is a large bluff on the west also nearly opposite the mouth of Rainbow Creek. This bluff can also be recognized as being about $1\frac{1}{2}$ miles north of the only island in the lake in this region. On the south side of this rock promontory the land surface rises steeply for about 500 feet. The fossil tree locality is most easily found by climbing up the cliff and walking inland in a southerly direction for several hundred yards, across an area dissected by a series of stream-cuts some of which are dry gullies and channels. Along the flat and up the south slope of one of these southeast-trending dry gullies specimens of petrified logs are found (Plate IV, figure 1). The specimens are scattered for a distance of three-quarters to a mile with two general areas of concentration; one higher up and the other 700 yards nearer the lake shore. In the intervening region only an occasional petrified tree fragment was found.

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Geological Setting

Geological data for this area are meagre. Geological Survey of Canada map, number 2063 (Dolmage, 1924), is the most complete report available. Several explorations into the general region of Chilko Lake have been made and reported on by G. M. Dawson, A.M. Bateman and J. D. MacKenzie of the Geological Survey of Canada and John D. Galloway and W. F. Robertson of the British Columbia Department of Mines. Geologists for the Survey of Resources Report of the Pacific Great Eastern Railway Lands (unpubl., *in* mss., 1929) visited the country to the north and east of the locality. However, none of these workers reported the presence of petrified stems, like those discovered by the prospecting party in 1946. This is understandable in view of the rugged nature of the terrain.

Dolmage's (1924) map includes the region in which the petrified logs were found. According to it, the region is underlain by volcanic rocks, shales, conglomerates, and limestones, all believed to be of Triassic age. The age of the sediments in which the specimens were found will be discussed below, and all that is necessary at this point is to indicate that their age is not Triassic but probably Lower Cretaceous or younger.

The slope on which the logs are found is covered by a mass of weathered boulders intermixed with larger pieces of petrified logs. Bedrock in this region consists of tuffs and breccias, appearing a soft olive-green when fresh but weathering to a light brown or tan. The beds strike east and dip gently north at about 10 to 14°. The breccias are made up of angular particles of assorted sizes. The condition of sedimentation and burial seems to have been that of a region into which logs floated and were quickly buried by volcanic materials. Small twigs and branches are common in the sediments. Grey shales, exposed higher up in the mountains near the head of the gully, yielded very poor, non-diagnostic fern remains and on maceration, no microfossils.

Description of Specimens

The specimens of logs or parts of stems are soft grey and are cut by numerous small white quartz veinlets (Plate IV, figure 2; Plate V). Silicification of the woody materials has taken place with the cells well preserved (Plate VI). All the specimens are dense and heavy. Details seen in cross-section of the wood reveal restricted areas where the inner walls of the tracheids are sculptured. This appears to be a phenomenon related to preservation, as it was noted only in local parts of the stem cross-section. In other zones both the compound middle lamella and the outermost cellulose wall are preserved. It is possible, however, that it is the inner and outer cellulose walls that are preserved and the middle layer that is missing, due to differential preservation. It also suggests that the inner wall cannot be distinguished from the compound middle lamella.

The diameter of the largest log measured is 22¼ inches. Most of the specimens are rounded or only slightly flattened as is illustrated by the data in Table I where the minimum and maximum diameters of individual specimens are listed.

Table I

Log Number	Diameter	Circumference	Length
	(inches)	(inches)	(inches)
1...	14–16	46	20
2...	8¾–9¾	29½	8½
3...	12–18	54½	26½
4...	18–22¼	61½	15½
5...	15	47	6½
6...	20	63	3

A maximum of 86 growth layers in a single log was counted. Layers in outer third of stem are much broader than those in the inner part.

The number of cells per growth layer varies between 9 and 75. The quadrangular cross-sectional shape of the tracheids cell is more apparent than real and a careful study shows the cells to have five or more sides. Tracheids vary greatly in size; measured along a radius of the log they are between 50 to 85 across and in a tangential direction between 40 to 68 (Plate VI, figures 1, 2).

In radial section the end walls of the tracheids are found to be long and taper to a rounded end (Plate VI, figure 5).

Pitting of the tracheid walls is confined to the radial walls. Pit sizes range between 22 to 28 in diameter and tend to occupy nearly the full width of the tracheid. Uniseriate pitting is typically present but occasional biseriate pitting can be found. If biseriate pits occur they are opposite in arrangement. Even though the pits are closely spaced they are not so crowded as to take on an angular appearance in face view. Pit apertures vary from elliptical to subcircular in shape. Pits also cover the end walls of the tracheids (Plate VI, figure 5).

Neither resin canals nor traumatic appearances of parenchyma were observed.

Numerous rays can be seen in tangential section (Plate VI, figures 3, 4). Individual rays range from 3 to 15 cells high. They are rarely biseriate and if so at one cell only. Many of the parenchyma cells are filled with a black, opaque substance probably resinous in nature. Their appearance in radial section is shown in Plate VI, figure 6.

Discussion

M. W. Bannan of the University of Toronto, to whom ground thin sections were submitted, confirmed the identification of the wood as *Cupressinoxylon*. This form genus was erected by Goeppert in 1850 to include coniferous woods with cupressaceous affinities. The genus has been reported from numerous localities on all continents and is distributed from the Antarctic to the Arctic.

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Kräusel (1949) in a summary study on fossil woods lists twenty-six Tertiary species belonging to *Cupressinoxylon,* five Cretaceous, three Jurassic and a very questionable assignment of a single specimen to the Permian. No Triassic species have been reported. Thus the Cupressaceae is for the most part a Tertiary family (Arnold, 1947). This opinion was also held by earlier workers such as Jeffrey (1908) when he said that "all evidence goes to show that the Taxodineae and Cupressineae did not exist before the very end of the Cretaceous or more probably before the beginning of the Tertiary". Coulter and Chamberlain (1917) remarked that although Cupressus-like twigs and cones have been described from the Jurassic there is no reliable evidence of the tribe earlier than the Upper Cretaceous.

It seems logical therefore to conclude that the strata from which these specimens were collected were erroneously dated by Dolmage (1924). The specimens described are similar to Tertiary and Cretaceous forms and are unlikely to have come from Triassic rocks. Approximately 35 miles to the north are great thicknesses of Lower Cretaceous strata and it would seem more logical to seek a correlation with these younger beds. However, this can be offered as a suggestion only as there is not other evidence at present known to offer in its support. That the beds are not Triassic seems conclusive, but a more definitive dating other than Cretaceous-Tertiary will have to await additional palæontological evidence.

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A REVISION OF THE DEVONIAN CORAL GENUS
SYNAPTOPHYLLUM SIMPSON

By D. J. McLaren

Introduction

In 1859 E. Billings described several new species of fossil corals from the Middle Devonian rocks of southwestern Ontario, including *Eridophyllum simcoense, Diphyphyllum arundinaceum*, and *D. stramineum*. Simpson, in 1900, grouped these three species into a new genus, *Synaptophyllum*, and cited *D. arundinaceum* as type species. Simpson incorrectly implied that Billings had assigned all three species to the genus *Eridophyllum*, although previous workers (e.g., Nicholson, 1874 and Lambe, 1899) had quoted Billings correctly. In the same paper, Simpson figured two new species, *Synaptophyllum baculoideum* and *S. segregatum*. Since the specimens on which Billings established *Diphyphyllum arundinaceum* have hitherto been considered lost, workers using *Synaptophyllum* have followed the description given by Simpson. As will be shown below, although Simpson cited *D. arundinaceum* as the type species of *Synaptophyllum*, his description of the genus is, in fact, founded upon the other species assigned by him to it, namely, Billings' *E. simcoense* and *D. stramineum*, and his own *S. baculoideum* and *segregatum*.

Several workers have recognized that because the types were lost, *Synaptophyllum* was unknown. Hill (1954, p. 25) employing the genus *Peneckiella* Soshkina stated that "this genus may be synonymous with *Synaptophyllum* Simpson . . . but the type specimens of the type species, *Diphyphyllum arundinaceum* . . . are lost". In the "Treatise on Invertebrate Paleontology", however, Hill (1956) lists both genera and assigns them to separate subfamilies of the family Phillipsastraeidae.

Several specimens labelled *Diphyphyllum arundinaceum* in Billings' handwriting, from the area cited in his original description of that species, and bearing a date prior to its publication date, have recently been found, during cataloguing of the types in the collections of the Geological Survey of Canada. These specimens agree well with Billings' description, and there can be little doubt that they form part of the material on which he founded his species. Sections show that the coral is without dissepimental tissue, possesses strongly convex tabulae, and a well-marked marginarium formed of peripheral stereozone. In fact the coral is a columnariid and may be referred without doubt to the family Stauriidae (following the classification of Hill, 1956).

In this paper a lectotype for *Diphyphyllum arundinaceum* Billings is chosen and the species redescribed, thus establishing the genus *Synaptophyllum* on the basis of the species originally cited as type. The relationships of this genus are discussed below. None of the species hitherto referred to *Synaptophyllum* is congeneric with *S. arundinaceum*. The types of the other species referred to *Synaptophyllum* by Simpson have been reexamined and all these species assigned to a new genus, *Acinophyllum*. The

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types of the corals referred to *Disphyllum* [*Synaptophyllum*] by Smith (1945) from the Upper Devonian of the Mackenzie River region have also been re-examined and the four species assigned to *Acinophyllum* or *Phacellophyllum* Gürich. Those referred by Smith to *D.* [*S.*] cf. *arundinaceum* (Billings) and *D.* [*S.*] *stramineum* (Billings) are renamed. Finally all other North American species hitherto assigned to the genus *Synaptophyllum* have been considered and are now grouped under *Acinophyllum*.

Throughout this report, type numbers preceded by the letters G.S.C. refer to specimens in the type collection of the Geological Survey of Canada; those preceded by N.Y.S.M. refer to specimens in the type collection of the New York State Museum, Albany, N.Y.

I should like to record my gratitude to Dr. Donald W. Fisher of the New York State Museum and Science Service for the loan of the type specimens of the species described by Simpson (1900) mentioned in this paper and for his permission to photograph and figure this material.

Family STAURIIDAE Milne-Edwards and Haime, 1850

Genus **Synaptophyllum** Simpson 1900

Type species. By original designation, *Diphyphyllum arundinaceum* Billings, 1859, pp. 134-135.

[*non*] *Synaptophyllum* Simpson of subsequent authors.

Diagnosis. Phaceloid coralla with long, slender, cylindrical corallites, rarely connected by lateral projections from corallite walls. Septa non-carinate, thin, may become dilated peripherally; of two orders; the major may either be short or extend nearly to the axis, the minor are short and rarely more than half as long as the major. The septa merge into a peripheral stereozone. There are no dissepiments. Tabulae complete, horizontal to distally arched axially and strongly deflected proximally near the periphery. Increase peripheral or axial.

Discussion. The smooth, non-carinate septa, complete tabulae, lack of dissepiments, and well-developed marginarium, show that *Synaptophyllum* belongs to the family Stauriidae Milne-Edwards and Haime Columnariidae of authors), as defined by Hill (1956) and Glinski (1957, p. 85). Some confusion still exists concerning several genera assigned to this family. Lang and Smith (1935a, p. 428) redescribed *Columnaria sulcata* Goldfuss, the lectotype (McCoy, 1849) of the genus *Columnaria* (and *see* Hill, in press). Despite the fact that *C. sulcata* possesses dissepiments, Soshkina (1952, p. 91) defined the genus *Columnaria* (and the *Columnariidae*) as being without dissepiments, and, in the same work, apparently used the genus *Fasciphyllum* in the sense in which others have used *Columnaria* and *Favistella*. *Synaptophyllum* differs from *Columnaria* sens. str. in lacking dissepiments, in the thickened marginarium, in the strongly curved tabulae, and in its phaceloid growth form.

Glinski (1957) considered *Columnaria* a disphyllid coral and grouped several Devonian species hitherto assigned to it in a new subgenus, *Favistella* (*Dendrostella*). *Synaptophyllum* differs from *Favistella* in the form

of its tabulae, and in its phaceloid habit. *F. (Dendrostella)* comprises spec-
ies with dendroid or phaceloid growth habit and differs from *Synapto-
phyllum* primarily in the form of its tabulae.

The type of the genus *Depasophyllum* Grabau 1936, *D. adnetum*
Grabau, has been redescribed by Ehlers and Stumm (1949). It resembles
Synaptophyllum in possessing complete tabulae that are strongly deflected
proximally ("pill-box lids"), although more of them join a previously
formed tabula at its point of deflection than in S. *arundinaceum*, where this
feature is relatively rare. *Depasophyllum* is included in the family Col-
umnariidae by Ehlers and Stumm; it may be a junior synonym of *Synapto-
phyllum*, but intermediate forms are unknown. For the present it seems
advisable to retain both genera because the type species differ in several
characteristics: (1) the corallites of *D. adnetum* are larger and more vari-
able in size than those of S. *arundinaceum;* (2) the growth habits differ;
(3) many of the buds of *D. adnetum* extend outward at right angles to the
parent corallite, whereas the budding corallites in S. *arundinaceum* diverge
at acute angles; (4) the septa of the former are uniformly short and appar-
ently of one order, whereas those of S. *arundinaceum* are variable in length
and well differentiated into two orders; (5) *D. adnetum* does not possess a
well-developed marginarium as does S. *arundinaceum*.

Grabau first used the name *Depasophyllum* in 1922 as a *nomen nudum*.
The name was subsequently used for two species of Chinese Carboniferous
corals by Yü (1933). This led Smith and Thomas (*in* Thomas, 1956) to
claim that *Depasophyllum* Yü antedates Grabau's subsequent designation
of a type species (in 1936) for the genus: namely *D. adnetum* Grabau from
the Middle Devonian of Michigan. Yü, however, did not designate a type
species, and consequently his usage (which is after December 31, 1930) is
not valid and does not establish the genus (I.R.Z.N., Article 25 (c) (3)).
Grabau's designation in 1936 is therefore valid. Smith and Thomas con-
sidered *Depasophyllum* Grabau a subjective synonym of *Amplexocarinia*
Soshkina 1928, but this genus is based on a small aulate solitary coral from
the Permian of Russia and appears to be unrelated to *Depasophyllum*.

As pointed out by Stumm (1949, p. 30), *Placophyllum* Simpson 1900,
type species *P. tabulatum* Simpson, is unusable as a genus, as two longi-
tudinal sections of small corallite fragments are all that exist of type ma-
terial. The sections are figured here (Plate X, figures 1, 2). Simpson in
his description (pp. 216-7) made no reference to any features that would
be observable in transverse section except for the statement that the coral
is similar to *Amplexus* internally. The type sections, however, although
longitudinal, show non-carinate septa at least as long as half the radius of
the corallites. It seems certain that the coral is correctly classified in the
family Stauriidae.

So far is it is known, *Placophyllum* bears some resemblence to *Synap-
tophyllum*, namely, in the mode of growth (pointed out by Simpson), and
in having complete tabulae which are deflected downward peripherally.
They differ in that the marginarium of *P. tabulatum*, if developed, may
be proportionally narrower, and the corallites are about twice the diameter
of those of S. *arundinaceum*. *Placophyllum* may be synonymous with *Syn-
aptophyllum*, but the present material is insufficient to allow any conclusion.

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Synaptophyllum as here defined includes only one species. Diagnosis is based only on *S. arundinaceum*. Other species placed in *Synaptophyllum* by Simpson included Billings' *Eridophyllum simcoense* and *Diphyphyllum stramineum* and two species named and figured by Simpson himself, *S. baculoideum* and *S. segregatum*. They are not congeneric with *S. arundinaceum* and are discussed below.

Simpson's description applies in no part to *S. arundinaceum* and it must be presumed that specimens of this species were not available to him. The type species of the genus is redescribed below. Billings' description, which is reprinted, is accurate and valid. If compared with Simpson's description of the genus founded on *S. arundinaceum* it may be seen to be remarkably dissimilar.

Synaptophyllum arundinaceum (Billings)

Plate VII, figures 1 to 3; Plate VIII, figures 1 to 5; Text-figures 4 to 6

1859. *Diphyphyllum arundinaceum* BILLINGS, pp. 134-5.
1874. *Diphyphyllum arundinaceum* (Billings), NICHOLSON, pp. 32-33, Pl. VI, figure 1.
1900. *Eridophyllum arundinaceum* (Billings), SIMPSON, p. 212.
    [name only, cited as type for *Synaptophyllum* n. gen.]
1901. [*non*] *Diphyphyllum arundinaceum* (Billings), LAMBE, pp. 162-3, Pl. XIV, figures 1, 1a, 1b.
1935b. [*non*] *Synaptophyllum arundinaceum* (Billings), LANG and SMITH, p. 561, text-figures 19, 20.
1945. [*non*] *Disphyllum* [*Synaptophyllum*] cf. *arundinaceum* (Billings), SMITH, p. 22, Pl. 12, figures 1a-d, 2a, b.
1949. [*non*] *Synaptophyllum arundinaceum* (Billings), STUMM, p. 74, Pl. 17, figures 19, 20.
1956. [*non*] *Synaptophyllum arundinaceum* (Billings), HILL, p. F281, figures 191, 6a, 6b.

Billings' description (dimensions in millimetres are added in square brackets). "Corallum forming large masses of long, cylindrical, straight or flexuous stems, from three to four lines [6-8 mm.] in diameter, sometimes in contact but usually distant from one to three lines [2-6 mm.] from each other; radiating septa thin, between forty and fifty in number, rarely reaching the centre; transverse diaphragms turning downwards on approaching the margin; two to four in one line [5 to 10 in 5 mm.]. In some of the corallites the walls are so thin and closely united that no separation can be observed, but in others of the same cluster an outer area is distinctly visible. There is usually a circular space in the centre of the corallites, half a line [one mm.] or a little more wide, into which the radiating septa do not penetrate, often, however, they reach the centre. The young corallites sometimes spring from the side of the parent with a slender base, and curving upwards immediately become parallel with those of the whole group. In large colonies frequent instances may be seen where instead of this lateral budding a bifurcation takes place, both branches being of the same size. In large groups, owing to the numerous additions of young, the corallites diverge slightly, as if radiating from a point. The colonies are from six inches to several feet in diameter, and large blocks of stone are of frequent occurrence, which are penetrated at right angles to the stratification by the closely crowded stems."

Material. Here chosen as lectotype: incomplete corallum, G.S.C. No. 3602, with thin sections Nos. 3602a-p inclusive; from 3 miles west of Cayuga, Ontario; collected by E. Billings, 1857.

Syntypes, five corallite fragments, G.S.C. Nos. 3431b-f inclusive, with two thin sections of No. 3431c; from lot 6, con. 1, Wainfleet tp., Welland co., Ontario; collected by E. Billings, 1857.

Syntypes, two corallite fragments, G.S.C. Nos. 3432a, b, and two thin sections 3432c and d; from "Walpole Tp., Haldimand Co., and Wainfleet Tp., Welland Co., Ontario"; collected by "Billings and Murray, etc., 1857".
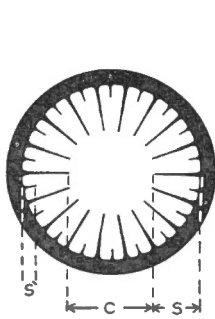
Figure 2
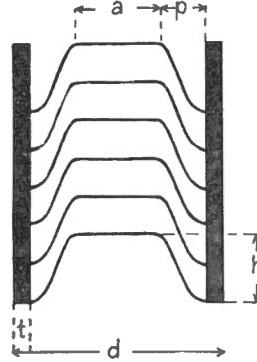
Figure 3

Text-figures 2, 3. *Synaptophyllum arundinaceum* (Billings). Diagrammatic representation of transverse and longitudinal sections showing dimensions used on the table below.

Dimensions of *Synaptophyllum arundinaceum*

(in millimetres)

—	Number of Measurements	Mean	Observed Range
Diameter of corallites (d)	20	5.5	3.8—6.3
Length of septa, major (s)	19	1.2	0.8—2.2
" " " minor ($\check{s}$)	19	0.3	0.1—0.6
Width of axis without septa (c)	12	2.0	0.7—2.8
Thickness of corallite wall (t)	15	0.4	0.3—0.7
Tabulae, height from base to crest (h)	17	1.8	0.8—3.8
" width of axial zone (a)	12	2.5	1.8—3.4
" width of peripheral zone (p)	13	1.1	0.8—1.5

The small letters in parentheses refer to the symbols shown on Text-figures 2 and 3.

Occurrence. Billings, in his original description of *Synaptophyllum arundinaceum*, reported its occurrence as "Rama's Farm, near Port Colborne, and in various localities in the townships of Walpole, Oneida, Cay-

uga, and Wainfleet, in the Corniferous limestone". Glued to the lectotype is a label on which is written in Billings' own hand: *"Diphyphyllum arundinaceum* 3 miles west of Cayuga E.B.   57/"

This locality and the others mentioned by Billings are all presumed to lie within the outcrop area of the "Onondaga Limestone" of the Niagara Peninsula of southwestern Ontario. These beds have recently been included in the Bois Blanc formation by Sanford and Howie (1957). Landes, Ehlers, and Stanley (1945) first described this formation in the Mackinac Straits region of Michigan and discussed its fauna, stratigraphic relations, and correlation with beds in southwestern Ontario and western New York. The Blois Blanc is shown to lie within the Onesquethaw Stage of the Ulsterian Series. Faunal lists given by Best (MS. 1953) confirm the age relationships of the Bois Blanc of Niagara Peninsula.

Description. The corallum is phaceloid and large; the lectotype, a fragment of a coral, is 28 cm. wide, 30.5 cm. high, and 5 cm. thick. The corallites are cylindrical, slightly sinuous, and subparallel to slightly diverging. Their diameters average 5.4 mm., with a range between 3.8 mm. and 6.3 mm. The surface of the epitheca is marked with weak annular rings or wrinkles 0.7 mm. to 1.0 mm. apart, and on some corallites is also longitudinally striated; a few corallites are smooth. Small projections from the surface are not common, but in places occur on the outside of gently sinuous bends on some corallites. They are probably the broken ends of connecting processes, but none is preserved complete on the lectotype. Increase is lateral, usually with slender offsets that rapidly attain mature diameters; some corallites branch equally, and the daughter offsets attain full diameter from the point of bifurcation. In either case the budding corallites diverge at an acute angle.

The corallites are separated by a distance less than their diameters—commonly a spacing of 2 or 3 mm., with a maximum of about 6 mm. Some adjacent pairs are in contact for several mm.; in one case contact was maintained for a distance of 20 mm.

No calyces are preserved on the lectotype, but a fragment of one syntype (3431c), shows a flat-bottomed shallow pit with vertical walls and a narrow, plane, calicular platform supported by the marginarium.

There are 18 or 19 septa of each order; they are non-carinate and tend to be dilated peripherally. The major septa are very unequal in length, in some transverse sections they extend nearly to the axis and in others they stop at the margin of the axial part of the tabularium, their axial ends abutting against the downturned intercepted edges of the tabulae. The minor septa vary from scarcely perceptible ridges on the inner side of the marginarium to 0.6 mm. in length. Peripherally the septa merge into a marginarium formed partly by septal dilation and partly by the deposition of lamellar tissue tangentially to the corallite wall, between the septa. The marginarium is covered externally with a thin, dense, epitheca.

In longitudinal section the tabulae are complete, horizontal to distally arched axially, and deflected proximally near the periphery; there are between 5 and 7 in 5 mm. Before joining the marginarium the tabulae bend outwards again, and meet the corallite wall nearly at right angles. Rarely, a tabula joins the adjacent proximal tabula at its point of deflection and so does not reach the corallite wall.

There are no dissepiments.

A fragment of syntype 3431c has a tapering connecting process that projects at right angles to the coral wall; its length is 4.5 mm. and minimum diameter 1.5 mm. In section it is seen to be formed entirely of marginarium tissue at its narrowest point, but where it widens, nearer the corallite wall, prolongations of septa extend into it. The process is attached at one end only, the broken surface of the unattached end presumably joined another corallite in the complete corallum.

Discussion. The lectotype is partly silicified and consequently the microstructure of the septa and marginarium is only preserved in patches. Some of the corallites are thinly coated with a repent bryozoan (Plate VIII, figures 5a, b). The coral occurs in a matrix of dark brown, argillaceous, bioclastic limestone, fine to medium grained and variably siliceous.

Figure 4a

Figure 4b

Figure 5a

Figure 5b

Figure 7a

Figure 7b
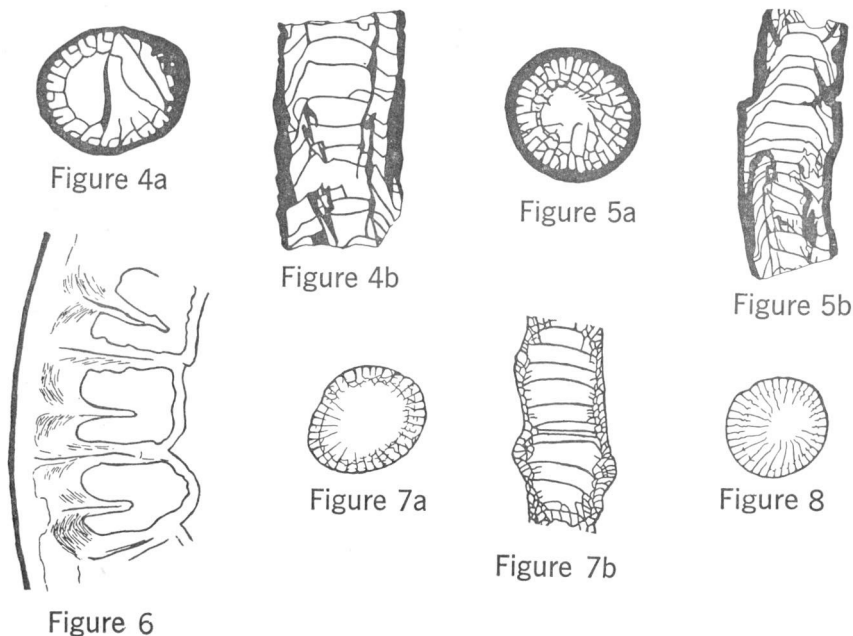
Figure 8

Figure 6

Text-figures 4-6. *Synaptophyllum arundinaceum* (Billings). 4a, 4b, transverse and longitudinal sections of lectotype G.S.C. Nos. 3602i and j, x3; 5a, 5b, transverse and longitudinal sections of syntype G.S.C. Nos. 3432c and d, x3; 6, drawing of enlargement of part of lectotype G.S.C. No. 3602k, approx. x20.

Text-figure 7. *Acinophyllum simcoense* (Billings). 7a, 7b, transverse and longitudinal sections of hypotype G.S.C. Nos. 3436c and d, x3.

Text-figure 8. *Acinophyllum stramineum* (Billings). 8, transverse section of lectotype G.S.C. No. 3431, x3.

It should be noted that Billings in his original description made no mention of dissepiments or of connecting processes between corallites; furthermore, his measurements all agree well with the lectotype, as does his description of the shape of the tabulae.

The specimen figured by Lambe (1901) as *Diphyphyllum arundin-aceum* cannot be found among the collections of the Geological Survey of Canada. It is apparent that the species is not *S. arundinaceum* but belongs to the genus *Acinophyllum;* nothing more may be said of it at present.

The diagrammatic figures of *Synaptophyllum arundinaceum* given by Lang and Smith (1935b) and copied by Stumm (1949) and Hill (1956) are probably of *Phacellophyllum fenense* n. sp. (*see* page 29).

Family PHILLIPSASTRAEIDAE C. F. Roemer, 1883

Subfamily PHILLIPSASTRAEINAE C. F. Roemer, 1883

Genus *Acinophyllum* new

Type species. Eridophyllum simcoense Billings, 1859, p. 132, figure 27.

Diagnosis. Compound disphyllid corals with dendroid or phaceloid coralla made up of slender cylindrical corallites which may be interconnected by lateral projections from corallite walls. Epitheca thin, may be transversely banded; interseptal ridges present. Increase lateral. Septa of two orders, peripherally they are weakly dilated and carinate, commonly with zigzag carinae; minor septa short; major septa short or long, but never extend to axis. Tabularium wide, with well-spaced more or less horizontal tabulae, commonly complete but sometimes incomplete. Dissepimentarium narrow, formed of one or two, rarely more, rows of small globose dissepiments. Trabecular grouping of "*Disphyllum* type".

Discussion. Acinophyllum includes many species previously assigned to *Synaptophyllum.* Stumm (1949, p. 37) placed *Peneckiella* Soshkina in synonymy with *Synaptophyllum,* interpreting *Peneckiella* as described by Soshkina and *Synaptophyllum* as then understood. Hill (1954, p. 25) noted that *Peneckiella* may be synonymous with *Synaptophyllum.* Soshkina (1939, p. 23) named *Diphyphyllum minus* Roemer as type species of *Pen-eckiella,* a selection which has made interpretation of this genus difficult. In both Roemer's (1855) and Frech's (1885) figures of this species the dissepimentarium is shown as consisting of a single row of dissepiments whose outer ends rest against the coral walls; there are no horseshoe dissepiments. Furthermore, in Frech's figure of a longitudinal section of a corallite (1885, Plate I, figure 3a) the dissepimentarium is crossed by axially and distally directed lines, presumably representing trabeculae that may have formed carinae. This is described by Frech (p. 35) as "Die Septa bestehen, wie ein Längsschliff zeigt, aus verschmolzenen Dornen, die schräg nach innen und oben gerichtet sind". Frech's remarks were based on Roemer's specimens. From this description it would appear likely that *Acino-phyllum simcoense* is congeneric with *Diphyphyllum minus* and therefore with *Peneckiella.* But *D. minus* has been described several times since Frech and on no occasion has the description agreed closely with his.

Lang and Smith (1935b, p. 576) redescribed and figured the species (from a British Museum specimen and not the type material) as possessing peripheral horseshoe dissepiments; they made no mention of carinae on the septa. Schouppé (1949) redescribed *D. minus* as *Macgeea* (*Thamnophyl-lum*) *caespitosum* (Goldfuss) var. *minus* (Roemer), possessing horseshoe dissepiments and smooth septa. He thus put *Peneckiella* in synonymy with *Thamnophyllum.* In this he was followed by Różkowska (1953).

Soshkina (1951, p. 106) described several Russian coral specimens as *Peneckiella minima* (Roemer) [sic] (= *Diphyphyllum minus*). In them the septa are weakly thickened peripherally but non-carinate, and there are one or two rows of normal dissepiments. Flügel (1956) also redescribed the species as possessing horseshoe dissepiments (which he figured diagrammatically only), and smooth septa; but he considered *Peneckiella* a valid genus distinct from *Thamnophyllum*. Unlike Schouppé, Flügel examined the type specimen of *D. minus*.

Under these circumstances one must follow Flügel, the only author to have examined Roemer's type of *D. minus* recently, and restrict *Peneckiella* to corals with smooth septa and peripheral horseshoe dissepiments[1].

The species here assigned to *Acinophyllum* may appear at first sight to be congeneric with *D. minus* Roemer, but they are certainly not congeneric with the interpretation of *D. minus* of several modern workers.

At present it seems best to place several North American species with carinate septa but without true horseshoe dissepiments in a new genus, *Acinophyllum*. Should *D. minus* subsequently be shown to possess a similar structure, then *Acinophyllum* may be considered a junior synonym of *Peneckiella*. Alternatively, if the type specimens of *D. minus* are shown to possess the structures described by Flügel, then *Acinophyllum* will remain as a genus distinct from *Peneckiella*.

In recent classifications of Rugose corals most workers separate disphyllid-type corals possessing horseshoe dissepiments from those without; the distinction being considered of at least subfamily rank (Stumm 1949, Wang 1950, Soshkina 1952, Różkowska 1949 and 1953, Hill 1956, but not Lang and Smith 1935b). Morphologically, a single rank of globose dissepiments whose outer edges abut against the coral wall, do not constitute horseshoe dissepiments, although they have been so called on numerous occasions. True horseshoe dissepiments (Lang and Smith, 1935b) are morphologically and were presumably functionally different, and, as Wang (1950) has shown, are the reflection of the inner trabecular structure of the septa. An accurate definition is given by Soshkina (1952, p. 120): ". . . form of small horseshoes, each of which abuts against the underlying vesicle with both its edges". *Acinophyllum* possesses no such structure and is consequently classified in the subfamily Phillipsastraeinae of the family Phillipsastraeidae (Hill, 1956).

Acinophyllum differs from *Disphyllum* de Fromentel in commonly possessing connecting processes between corallites; carinate major and minor septa, which are weakly but equally dilated peripherally; no lateral tabellae; a narrow dissepimentarium, with seldom more than two rows of small globose dissepiments.

From *Cylindrophyllum* Simpson, *Acinophyllum* differs in the smaller size of the corallites; the presence of connecting processes; septa which are only carinate peripherally, commonly with zigzag carinae, (in *Cylindrophyllum* the carinae are of cross-bar type and occur in axial as well as peripheral parts of the septa); septa never extending to the axis and weakly dilated peripherally; dissepimentarium narrow, with rarely more than two rows of small globose dissepiments.

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[1] In a recent paper (*Neues Jahrb. Geol. Paläontol.*, Abh. 106, pp. 139-244, 1958) Schouppé defines and figures *Peneckiella* as possessing peripheral horseshoe dissepiments and without prominent carinae.

Acinophyllum simcoense (Billings)

Plate VIII, figure 6; Plate IX, figures 1, 2; Text-figure 7

1859. *Eridophyllum Simcoense* BILLINGS, p. 132, figure 27.

1874. *Eridophyllum Simcoense* (Billings), NICHOLSON, pp. 34-35, Pl. 6, figure 5.

1876. [*non?*] *Diphyphyllum Simcoense* (Billings), ROMINGER, pp. 123-4, Pl. 46, figures 3, 4. [Rominger places *Diphyphyllum stramineum* in synonymy.]

1892. [*non*] *Amplexus* or *Diphyphyllum* (Sp.) WHITEAVES, pp. 270-1, Pl. 35, figures 2, 2a. [Placed in synonymy with *E. simcoense* by Lambe (1899) and others.]

1899. *Diphyphyllum simcoense* (Billings), LAMBE, pp. 242-3.

1900. [*non?*] *Synaptophyllum simcoense* (Billings), SIMPSON, figures 33, 34.

1901. *Diphyphyllum Simcoense* Billings, LAMBE, pp. 161-2, Pl. 13, figures 6, 6a, 6b. [Lambe places *Diphyphyllum stramineum* in synonymy in both of his papers.]

1945. [?] *Disphyllum* [*Synaptophyllum*] *simcoense* (Billings), SMITH, Pl. 13, figure 13.

Material and occurrence. Hypotype, G.S.C. No. 3436, incomplete corallum with four thin sections Nos. 3436a-d, inclusive. This specimen is that described by Lambe (1899) and figured by him (1901, Plate XIII, figures 6, 6a, 6b) as "type specimen". It bears a printed label which reads: "*Eridophyllum Simcoense* (Billings)—Corniferous: F1.—Woodstock, Ont.—Col. Murray 1860 (?)" and is probably not the specimen figured by Billings (1859, figure 27) who cites the locality for the species as "Rama's farm; and near the town of Simcoe". It is probable, however, that this specimen was originally identified by Billings. Nor is it the specimen figured by Nicholson (1874, Plate VI, figure 5), or by Rominger (1876, Plate XLVI, figures 3 and 4). The type or syntypes on which Billings founded the species are, to date, missing. It is highly probable that Lambe's hypotype is conspecific with Billings' *Eridophyllum simcoense*, but the species remains without a primary type.

Description. The corallum is phaceloid. The hypotype, a fragment of a larger coral, is 9.5 cm. wide, 5.5 cm. high, and 3 cm. thick. The corallites are cylindrical, slightly sinuous, and subparallel to radiating; they are between 4 and 5 mm. in diameter. The surface of the epitheca has strong irregular transverse wrinkles and constrictions, and weaker longitudinal interseptal ridges. The corallites are separated by a distance less than their diameters and are linked by numerous tubular connecting processes. Longitudinally on each corallite there are four, five, or six rows of these processes with a spacing of 3 to 5 mm. between adjacent processes in each row. Each process is strongly tapered between corallites, expanding from a minimum of less than one millimetre at the mid-point to a diameter of 2 mm. or more at the point of attachment to the corallite. Increase is lateral, the daughter corallites diverging at an acute angle from the parent. No calyces are preserved.

There are 18 or 19 septa of each order; the major are from 0.8 to 1.7 mm. long and never extend more than about half-way to the centre of the corallite; the minor are from half to equal the length of the major. The septa are weakly dilated peripherally with strong, thorn-shaped zigzag carinae, but are smooth axially. Some septa are zigzag peripherally, but straight axially.

The tabularium is wide and composed of complete, slightly convex tabulae, between 5 and 9 in 5 mm. The septal carinae are prominent in longitudinal section as small thorns directed distally or horizontally, protruding from the inner edge of the dissepimentarium.

The dissepimentarium is 0.3 to 0.7 mm. wide and consists of one, two, or rarely three rows of small, moderately globose dissepiments of variable size. The outer edges of the peripheral dissepiments rest against the thin epitheca and there are no horseshoe dissepiments.

The connecting processes are hollow extensions of the epitheca inside which both septal and dissepimental tissue may be recognized.

Discussion. See discussion under *Acinophyllum stramineum*.

Acinophyllum stramineum (Billings)

Plate IX, figures 3, 4; Plate X, figure 5; Text-figure 8

1859. *Diphyphyllum stramineum* BILLINGS, pp. 135-6.
1874. *Diphyphyllum stramineum* (Billings), NICHOLSON, p. 33, Pl. 5, figure 6.
1876. [?] *Diphyphyllum Simcoense* (Billings), ROMINGER, pp. 123-4, Pl. 46, figures 2, 3, 4.
1900. [?] *Synaptophyllum simcoense* (Billings), SIMPSON, figures 33, 34 [originals figured by Smith, 1945].
1900. *Synaptophyllum segregatum* SIMPSON, figure 37.
1945. [?] *Disphyllum* [*Synaptophyllum*] *stramineum* (Billings), SMITH, Pl. 13, figures 3a, 3b, 3c [the originals of Simpson's figures of *Synaptophyllum simcoense* (Billings) 1900].
1945. [*non*] *Disphyllum* [*Synaptophyllum*] *stramineum* (Billings), SMITH, pp. 23-24, Pl. 13, figures 1, 2a, 2b, 4 to 12b incl.

Material and occurrence. Here chosen as lectotype, fragmentary corallites, G.S.C. No. 3431, with two thin sections; bearing label, attached to specimen, in Billings' handwriting: "*Diphyphyllum stramineum*, Lot 6, Con. 1, Wainfleet". Another printed label, also attached to the specimen, includes Billings' initials and the date collected, "E.B. 1857". From Billings' description (1859, pp. 135-6), it is clear that his species was founded upon more than one specimen, hence the specimen described here was presumably a syntype. The locality given on the label is the same as that cited in his description. No other specimens known to have been used by Billings in erecting the species have been found to date among the collections of the Geological Survey of Canada.

Description. The lectotype consists of a few fragments of individual corallites in a porous bioclastic limestone. Preservation is poor and it is difficult to cut sections thin enough to show the structure to full advantage. The corallum is presumably dendroid or phaceloid and the corallites are cylindrical and sinuous with a diameter between 4 and 4.5 mm. Billings noted that "in the more dense colonies the corallites often inosculate, and are sometimes connected by lateral processes" (1859, p. 136), but no processes are visible on the type specimen.

There are 19 or 20 septa of each order; the major are very variable in length, 0.6 to 2.1 mm., and may extend nearly to the axis; the minor are equal in length to the shortest major septa or shorter. The septa are weakly dilated in the dissepimentarium and attenuate axially; they are variably carinate with zigzag carinae peripherally, but are axially smooth.

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The tabularium is wide and formed of complete, more or less horizontal tabulae, 8 to 10 in 5 mm. Carinae directed sharply distally and axially are visible in longitudinal section. Only one row of regular, elongate, globose dissepiments is visible on the type, forming a dissepimentarium about 0.5 mm. wide. There are no horseshoe dissepiments; the outer edge of each dissepiment rests against the thin epitheca. One section revealed lines of trabeculae crossing the dissepiments at right angles, i.e., of the "*Disphyllum* type" of Wang (1950, p. 187).

Discussion. Several authors have placed *A. stramineum* in subjective synonymy with *A. simcoense*, presumably because the development of connecting processes is highly variable and not of specific taxonomic significance and the two species are otherwise closely similar. Smith (1945) reversed the names and placed *A. simcoense* in synonymy with *A. stramineum*. Stumm (1955, card 272) noted that the two species can only be distinguished by presence or absence of connecting processes. The type material is hardly sufficient to allow a positive conclusion to be drawn, particularly as this material gives no knowledge of the variability of the species involved. Certain differences are apparent, however, when the type specimens are compared, over and above the differing development of connecting processes:

A. simcoense	*A. stramineum*
1. Corallites irregular and wrinkled.	1. Corallites smooth.
2. Length of major septa less than half radius of corallite.	2. Some major septa extend nearly to axis.
3. Carinae strongly developed.	3. Carinae not so pronounced.
4. Dissepimentarium consists of one, two, or three rows of dissepiments.	4. Dissepimentarium consists of one row of dissepiments.
5. Tabulae possibly more widely spaced than in *A. stramineum*.	

The two species are, however, undoubtedly very similar and any of the differences listed might be due to individual variation or even, in some instances, differences in preservation. Certainly Billings' description suggests that the two species show much greater variation than is apparent in the limited type material. If it is subsequently shown that the species intergrade and are indeed conspecific, then *A. stramineum* should be put in synonymy with *A. simcoense* and not the other way round, following Rominger (1876) and Lambe (1901) and not Smith (1945).

Synaptophyllum segregatum Simpson (Plate X, figure 5) from the Onondaga limestone, Clarksville, Albany co., N.Y., is known only from a single transverse section containing six more or less complete corallites, two of them joined by a connecting process (holotype No. 336, New York State Museum). In diameter and septal development the coral appears to be identical to *A. stramineum*. Furthermore, it is apparent from the section that there is probably but one row of dissepiments, forming a narrow dissepimentarium. On these grounds, *S. segregatum* is considered a subjective synonym of *A. stramineum* which may in turn ultimately prove to be conspecific with *A. simcoense*.

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Acinophyllum baculoideum (Simpson)

Plate X, figures 3, 4

1900. *Synaptophyllum baculoideum* SIMPSON, p. 213, figures 35, 36.

Material and occurrence. Syntypes 334 and 335, New York State Museum, from the "Onondaga limestone, Leroy, Genesee Co., N.Y". Syntype 335, consisting of one incomplete and two complete corallites in transverse section, is here selected as lectotype, on the assumption that the three corallites formed part of the same corallum.

Description. The coral is known only from three complete and one incomplete transverse sections of separate corallites. Their diameters range from 6.3 to 7.9 mm. Two of the corallites have tapering outgrowths, 2 and 3 mm. long, with broken outer ends, that are presumably incomplete connecting processes. There are 22 or 23 major septa, 2.1 to 2.9 mm. long, from one-half to three-quarters of the corallite radius. The alternating minor septa are half as long as the longer major septa. Carinae are irregularly developed. There appears to be little septal dilation. Tabulae and dissepiments are present. Traces of tabulae seen in transverse sections suggest that these were complete and approximately flat; nothing is known of their spacing. The dissepimentarium is about one-quarter of the corallite radius in width, but the number of rows of dissepiments is unknown. Septa and dissepimental tissue continue into the connecting processes.

Acinophyllum camselli (Smith)

1945. *Disphyllum [Synaptophyllum] camselli* SMITH, p. 23, Pl. 12, figures 4a-h.

Upper Devonian, Bouvier River, N.W.T.

The writer is familiar with Bouvier River, and, following reference to Whittaker's field notebooks, it is clear that this coral comes from a series of sandy limestones and shales, below the Grumbler formation, very close to the lowest outcrop on the river (*see* Whittaker, 1923, p. 89B).

To Smith's description, the following observations may be added: the septa are variably carinate and dilated at the inner edge of the dissepimentarium. There are no horseshoe dissepiments. The inner margin of the dissepimentarium is thickened, and forms an inner wall.

Acinophyllum crassiseptatum (Ehlers and Stumm)

1949. *Synaptophyllum crassiseptatum* EHLERS and STUMM, pp. 28-29, Pl. 2, figure 3; Pl. 6, figures 1-6.

Middle Devonian, Potter Farm formation, Traverse group, Michigan.

Acinophyllum fasciculum (Meek)

1877. *Diphyphyllum fasciculum* MEEK, pp. 29-31, Pl. 2, figures 4, 4a, 4b.

1940. *Synaptophyllum fasciculum* (Meek), STUMM, pp. 62-63, Pl. 7, figure 9; Pl. 8, figures 10a, 10b.

1948. *Synaptophyllum fasciculum* (Meek), STUMM, p. 44, Pl. 11, figure 5; Pl. 12, figures 3, 5, 7, 10.

Upper Devonian, Devil's Gate formation, Nevada; Martin limestone, Arizona.

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Acinophyllum occidens (Stumm)

1948. *Synaptophyllum occidens* STUMM, p. 44, Pl. 11, figure 8; Pl. 12, figure 4; Pl. 13, figure 4.

Upper Devonian, Martin limestone, Arizona.

Acinophyllum ? rectiseptatum (Rominger)

1876. *Diphyphyllum rectiseptatum* ROMINGER, p. 124.
1955. *Synaptophyllum rectiseptatum* (Rominger), STUMM, Card 269, 3 figures [of syntypes].

Middle Devonian, Dundee limestone, Michigan.

Subfamily Phacellophyllinae Wedekind, 1921

Genus *Phacellophyllum* Gürich 1909

Type species. By monotypy, *Lithodendron caespitosum* GOLDFUSS, 1826, p. 44, Plate XIII, figure 4.

Several authors have considered *Phacellophyllum* a subjective synonym of *Thamnophyllum* Penecke 1894. Lang and Smith (1935b, pp. 563-4, and 581-2) selected *Thamnophyllum stachei* Horn and Penecke as lectotype of that genus and considered it generically distinct from *Phacellophyllum*. Schouppé (1949), in a long discussion of *Thamnophyllum*, considered it a subgenus of *Macgeea* and included *Fascicularia* Dybowski and *Peneckiella* Soshkina as well as *Phacellophyllum* in synonymy. He figured no new material but reproduced Penecke's figures. He was followed by Różkowska (1953) in considering *Phacellophyllum* a junior synonym of *Thamnophyllum*. Flügel (1956) merged *Phacellophyllum* with *Macgeea* (*Macgeea*), leaving *Thamnophyllum* as a distinct subgenus of *Macgeea*.

In a recent paper of considerable interest Różkowska (1957) has followed Soshkina (1941) in including *Thamnophyllum* in a new family, Thamnophyllidae and discusses the morphology and ontogeny of the genus at length. Unfortunately, she makes little reference to the chosen type, *T. stachei*, save to note that it is a most primitive species. *T. stachei* is a Lower Devonian form, whereas all of the species discussed by Różkowska are of Middle Givetian to Frasnian age. Furthermore, it is by no means certain that *T. stachei* is congeneric with the species included by her in *Thamnophyllum*. Lang and Smith (1935b), who were conservative taxonomists and could in no sense be termed "splitters", considered *T. stachei* generically distinct from, e.g., *Phacellophyllum caespitosum* Goldfuss, a species Różkowska includes in *Thamnophyllum*. The onus rests on subsequent authors to disprove this by reference to type species. Opinion cannot be allowed to influence taxonomic groupings until each group is firmly established. *Phacellophyllum* is a well-established genus; *Thamnophyllum* is inadequately known. Nothing further has been added to our knowledge of the latter since Lang and Smith's discussion, but from this it is not improbable that the genera are distinct. Such a conclusion in no way invalidates the importance of Różkowska's recent work (1957). *Thamnophyllum* may prove to be a primitive member of the lineage suggested by her on figure 27, and *Phacellophyllum* a more advanced form. The problem is taxonomic, but may in addition have some stratigraphic and evolutionary importance[1].

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[1] Schouppé (1958, *see* footnote p. 23) has further discussed *Thamnophyllum* and *Phacellophyllum*, but *T. stachei* is not figured or described.

Smith (1945) considered the Mackenzie corals he classified under *Disphyllum* [*Synaptophyllum*] to belong to *Disphyllum* [*Phacellophyllum*] at some point during his studies. In his discussion of *Disphyllum* (pp. 20-21) he stated: "To distinguish those members of *Disphyllum* which have horseshoe shaped dissepiments from the more typical forms which have ordinary dissepiments only, Gürich's name '*Phacellophyllum*' may be added in brackets indicating that the name is merely used in a genomorphic sense." Presumably a later change of view, or possibly an editorial change overlooked this inconsistency. Smith considered both *Phacellophyllum* and *Synaptophyllum* as genomorphs of *Disphyllum*.

Phacellophyllum fenense n. sp.

1935b. [?] *Synaptophyllum arundinaceum* (Billings), LANG and SMITH, p. 561, text-figures 19, 20.

1945. *Disphyllum* [*Synaptophyllum*] cf. *arundinaceum* (Billings), SMITH, p. 22, Pl. 12, figures 1, 2.

Material and occurrence. Holotype, G.S.C. No. 9330, three fragments, presumably from the same corallum, and seven thin sections, G.S.C. Nos. 9330a-g (four figured by Smith, 1945, Plate 12, figures 1a-d, 2a, b), from "Hay River; Grumbler Rapid, coral zone in lower limestone", N.W.T. This horizon lies within the Grumbler formation (Crickmay, 1957).

Discussion. This species has been well described and figured by Smith. He noted that horseshoe dissepiments are variable, but, for the most part, well-developed. In some well-preserved corallites there is a narrow row of widely spaced dissepiments between the inner horseshoe row and the coral wall (figure 2a); in others the horseshoe dissepiments are in contact peripherally with the wall of the coral (figure 2b); in one section (figure 1d) the horseshoe dissepiments have partly "unrolled" and their outer ends rest against the coral wall. Diverging trabeculae fans of the *Phacellophyllum* type (Wang, 1950, p. 187) are visible in some sections.

Lang and Smith (1935b, p. 561) figured diagrammatic transverse and longitudinal sections of *Synaptophyllum arundinaceum*, but did not say on what specimens these are based. It is highly probable that the figures represent *Phacellophyllum fenense*. In 1935 Smith was engaged in his study of Whittaker's collections of corals from the Upper Devonian of the Mackenzie River region and Lang and Smith's figures agree closely with the type specimens of the Hay River form. These figures were generally accepted as being an authoritative representation of *Synaptophyllum* and were reproduced by Stumm (1949), Schouppé (1949) and Hill (1956).

Phacellophyllum tructense n. sp.

1945. *Disphyllum* [*Synaptophyllum*] *stramineum* (Billings), SMITH, pp. 23-24, Pl. 13, figures 1, 2a, 2b, 4, 5a, 5b, 7, 8, 10a, 10b; [*non*] figures 3a, 3b, 3c, 6, 9, 11a, 11b, 12a, 12b.

Material and occurrence. Holotype, G.S.C. No. 6310, fragment of corallum (Plate 13, figure 1, Smith, 1945), and seven thin sections, G.S.C. Nos. 6310a-g (two figured by Smith, figures 5a, 5b, 7) from "conspicuous coral horizon with marcasite nodules near top of cliff; about 19 miles above river

mouth", Trout River, N.W.T. This is probably Whittaker's bed *f* (1922, p. 53B). From recent field work by the author, this horizon is known to be about 140 feet below the top of the Upper Devonian Grumbler formation.

Hypotype, G.S.C. No. 6309, large fragment of corallum (Plate 13, figure 2a, Smith, 1945), and four thin sections, G.S.C. Nos. 6309a-d (two figured by Smith, figures 4, 8, 10a, 10b) from "third falls; bed *b*, a dolomitic limestone with a few corals", Trout River, N.W.T. Reference to Whittaker's field notebooks shows that this is not the bed *b* of his published section of Trout River (1922, p. 53b), but corresponds to his bed *m* of that section and is found at the top of the Third Falls, i.e., the uppermost falls on Trout River. This represents a horizon within about 20 feet of the top of the Grumbler formation.

Discussion. The coral was described by Smith (pp. 23-24), but his description included other forms as variants. The species *P. tructense* is that which is referred to as "typical" or "usual" in his description. Most of the characters he noted as representing variation within the species are in fact displayed only by those specimens now considered specifically and generically distinct. The species is characterized by its diameter, 3 to 4 mm.; 15 septa of each order, major and minor, both short and strongly dilated; tabulae complete, gently convex to strongly concave distally; an inner series of horseshoe dissepiments sometimes masked by abundant secondary schlerenchyme, and an outer series of narrow, nearly flat, dissepiments. No major variations in these characters have been observed in the types or in other individuals collected from the same horizons.

The remaining corals included by Smith in his description and figures are more poorly represented among the type material. Examination of the thin sections figured by him (Plate 13, figures 6, 9, 12a, 12b) shows that the specimens possess normal dissepiments, those of horseshoe type are not present, the septa are longer, not strongly thickened, and are more numerous (36 to 40). Furthermore, they occur in beds which are now classified as underlying the Grumbler formation below those in which *P. tructense* is found. The material is insufficient to warrant naming a new species at present, but there is little doubt that they may be referred to the genus *Disphyllum* de Fromentel.

Specimen No. 6023 is missing from the Geological Survey collections, but from Smith's figures (11a, 11b) it is plainly not conspecific with *P. tructense.*

Phacellophyllum? densum (Smith)

1945. *Disphyllum [Synaptophyllum] densum* SMITH, pp. 22-23, Pl. 12, figures 3a-c.

The holotype (G.S.C. No. 6312) was collected at a rapids $5\frac{1}{2}$ miles above Alexandra Falls, Hay River, N.W.T., from the Lower Grumbler formation.

Smith noted that the species is similar to '*D cf. arundinaceum*' (= *Phacellophyllum fenense*) but the septa are more strongly dilated and the dissepiments are not of horseshoe type. This would seem to exclude it from the genus *Phacellophyllum*, but examination of Smith's type material reveals an area of trabecular divergence within the dissepimentarium that is visible in all longitudinal sections, and one section in which horseshoe dissepiments are developed. The coral may be classified with the subfamily Phacellophyllinae, but is referred to *Phacellophyllum* tentatively for the present.

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PLATES I to X

PLATE I
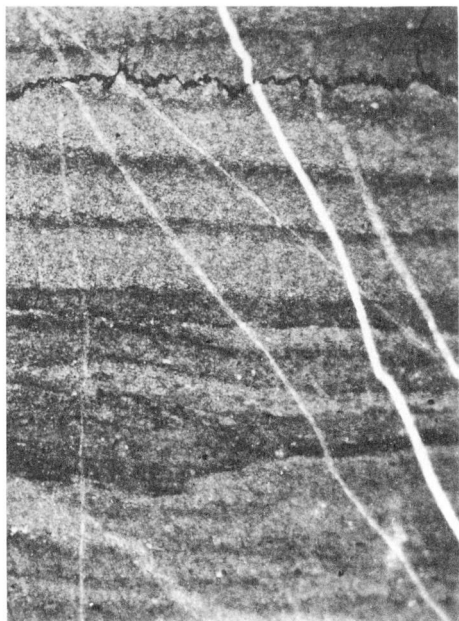
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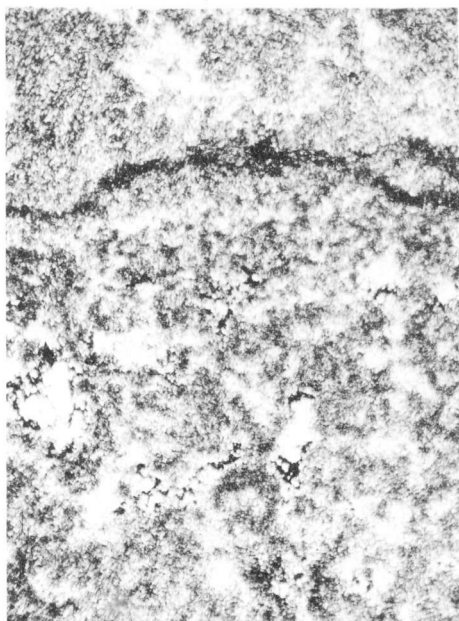
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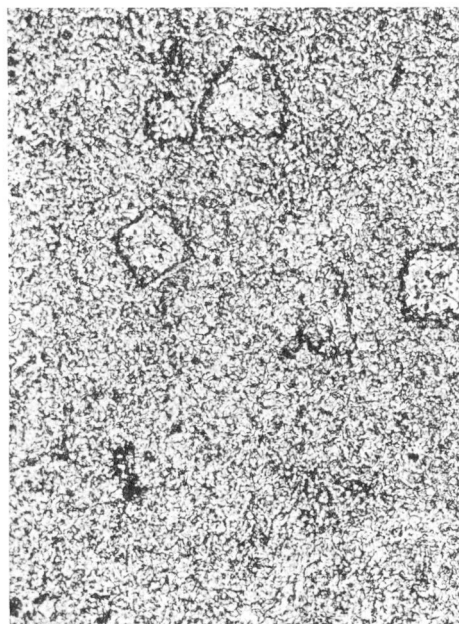
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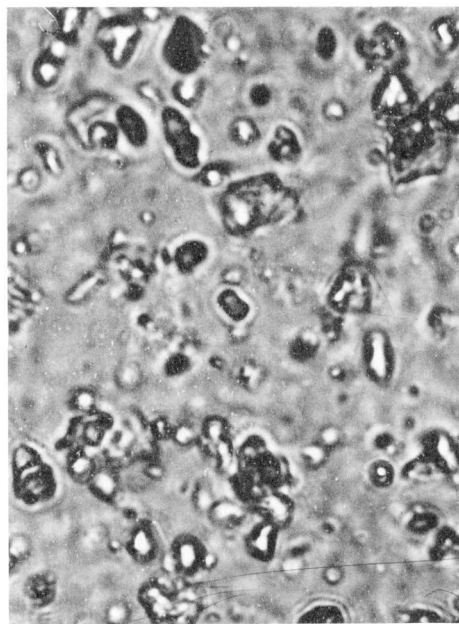
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PLATE I

Figure 1. Thin section of limestone type that proved rich in filaments, showing fine colour banding with micro-unconformities and small wash-outs; micro-stylolite near top displacing two of three calcite veinlets that cross it. x 16.

Figure 2. Thin section of limestone type that proved poor or lacking in filaments, showing how partial recrystallization has produced a coarser, grumous texture. x 25.

Figure 3. Thin section of limestone of type illustrated in figure 1, showing dense granular nature of rock and some crystals of authigenic fluorite. x 200.

Figure 4. Disintegrated edge of thin section of limestone of type illustrated in figure 1 showing elongate and irregular grains of calcite. x 675.

All of the specimens figured are from the upper 10 feet of the Flume formation near Job Creek in the Front Ranges of the Alberta Rocky Mountains.

Figure 1. Mat of undisturbed filaments from a limestone chip. Note the density of organic material and the angularity of the filamentous mat, which retains the shape of the chip after treatment with HCl. x 26.

Figure 2. A group of filaments from an aggregation similar to that in figure 1. Note the intertwining and lack of orientation of the strands. The circular structure in the centre of the figure is an oil droplet and not a fungal spore. The angular particles are clay minerals caught in the filaments. x 360.

Figure 3. A greater enlargement of the filaments showing the lack of orientation. Note the branched filament at the lower right. x 675.

All of the specimens figured are from the upper 10 feet of the Flume formation near Job Creek in the Front Ranges of the Alberta Rocky Mountains.

PLATE II

1

2

3

PLATE III

1

2

3

4
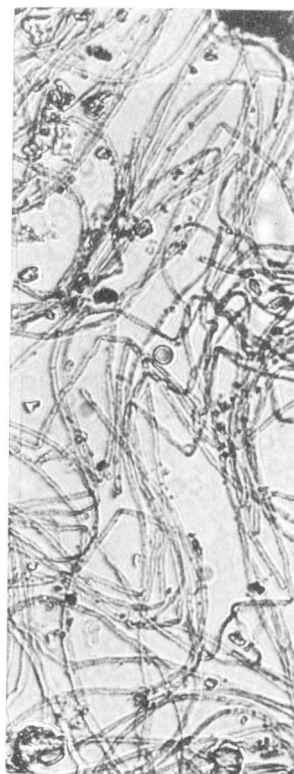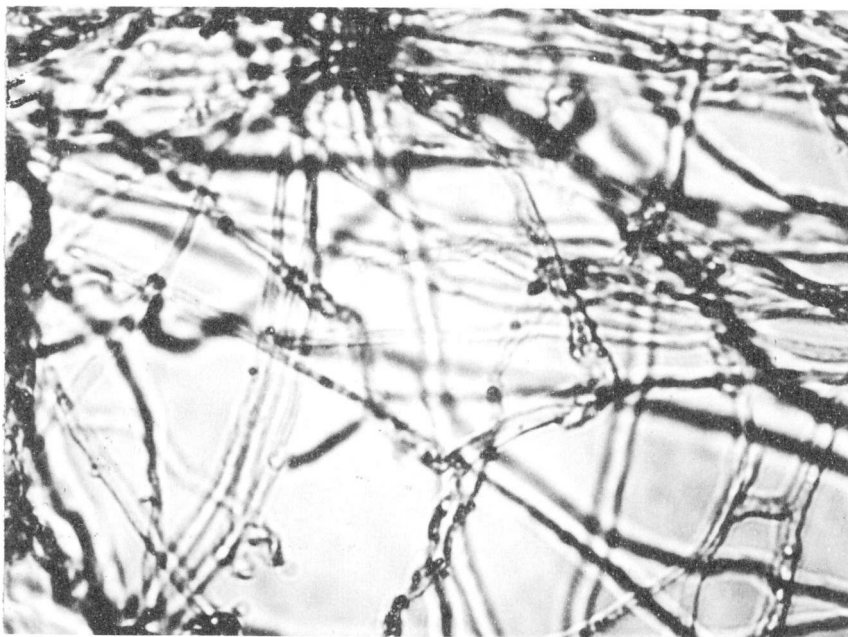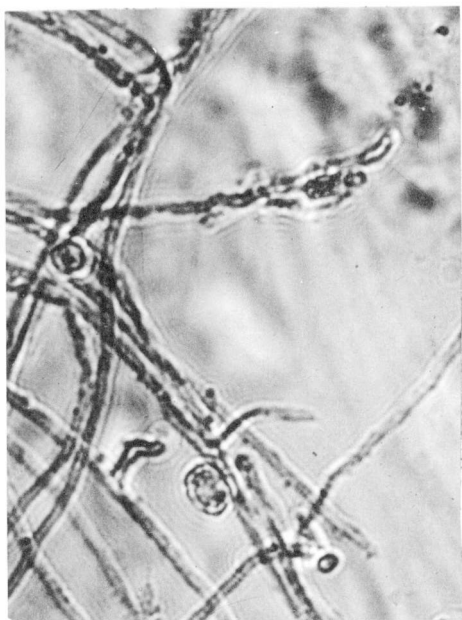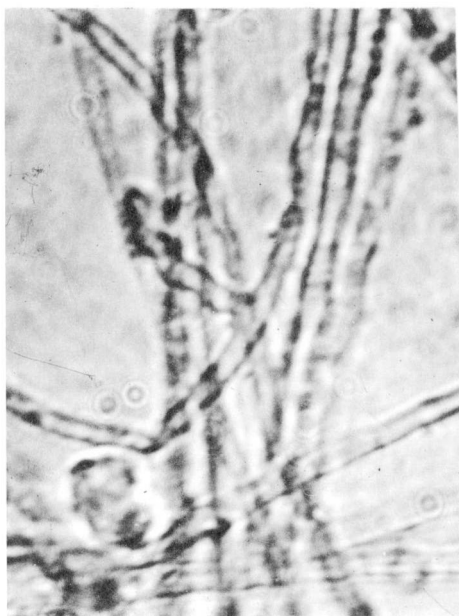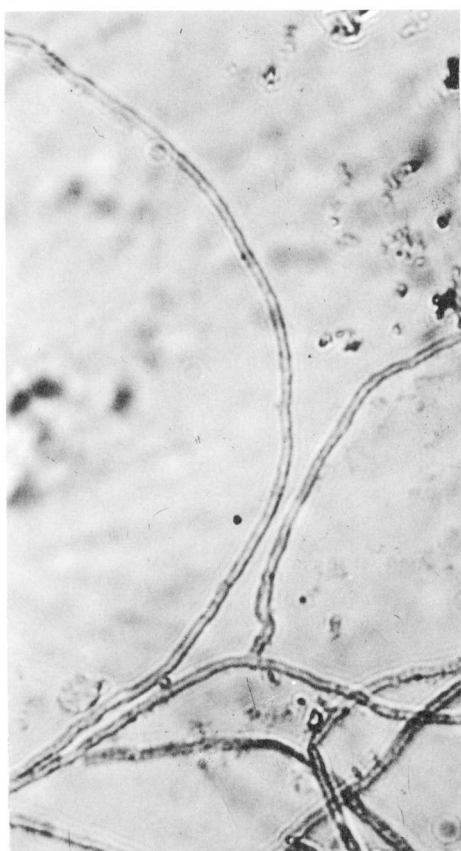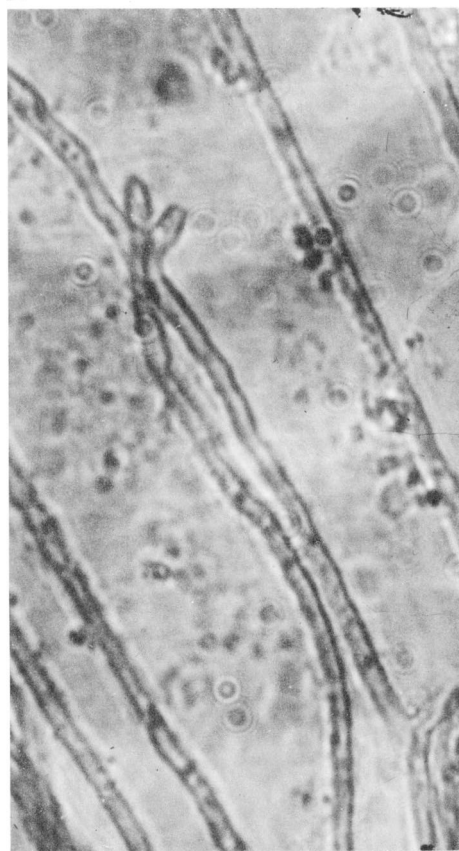
Figure 1. A short branch coming off a parent filament in the lower left quarter. Slightly to the right there is probably a longer branch. x 675.

Figure 2. Short branch in the centre of the photo. Above and below this branch are filament septa. x 1500.

Figure 3. Well-developed branch filament in the centre lower third. Slightly above and on the left of the branch, one of the rare septa is visible. x 675.

Figure 4. Strand lying diagonally across the figure from upper left to lower right with two branches, one near top, and the other near bottom. x 1500.

All of the specimens figured are from the upper 10 feet of the Flume formation near Job Creek in the Front Ranges of the Alberta Rocky Mountains.

Figure 1. View at the locality along the small ridge on which numerous specimens of petrified logs are to be found. (All specimens were collected from or were measured at this site recorded as G. S. C. Plant Locality No. 4625.)

Figure 2. Cross-section of a petrified log of *Cupressinoxylon* showing growth layers. The white areas in the central part of the stem are quartz.

PLATE IV

1

2
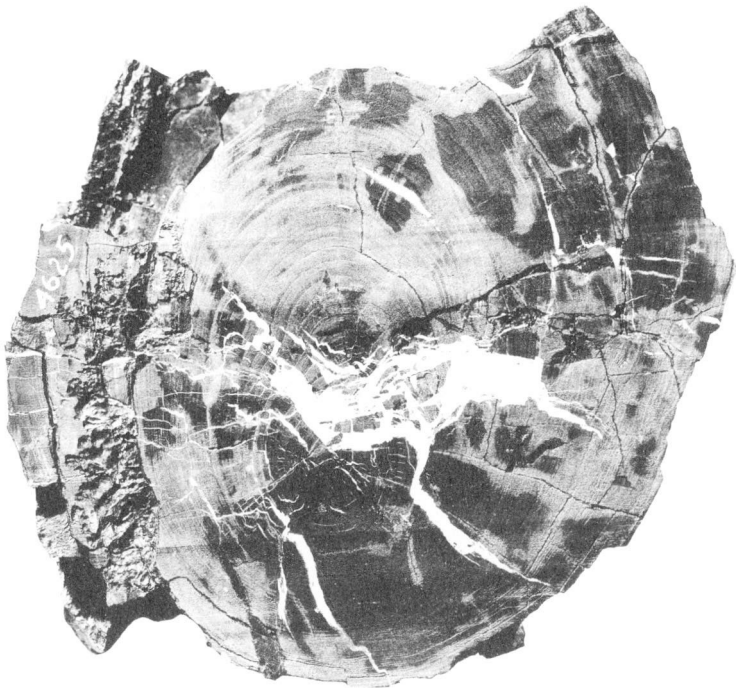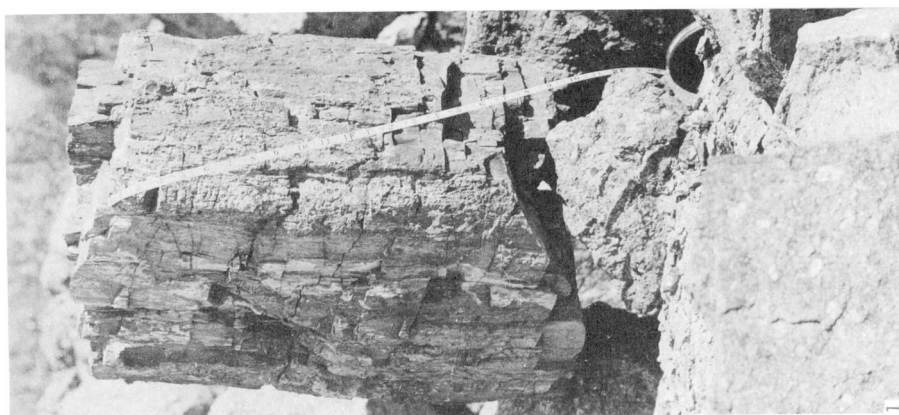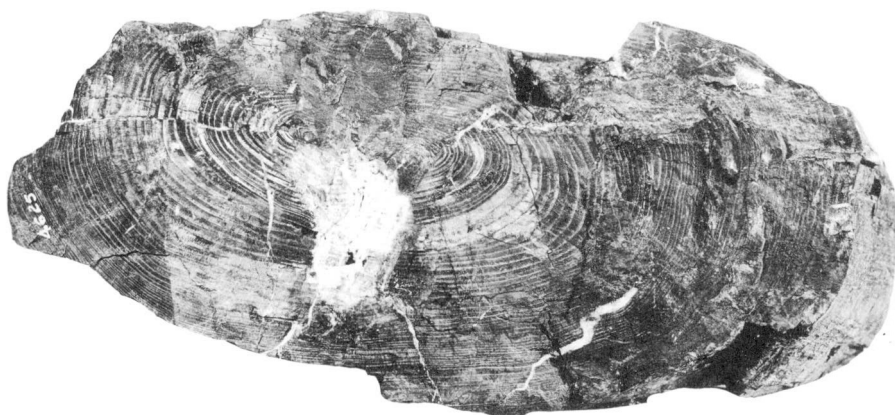
PLATE V

Figure 1. A 22-inch part of a log of *Cupressinoxylon* measured at the locality.

Figure 2. A naturally broken but somewhat flattened cross-section of a specimen of *Cupressinoxylon*. Note the growth layers.

Figure 3. Cross-section of a log of *Cupressinoxylon* found at the locality.

PLATE VI

PLATE VII

1a

1b

2a

2b
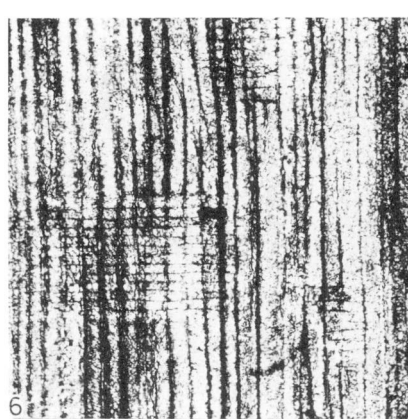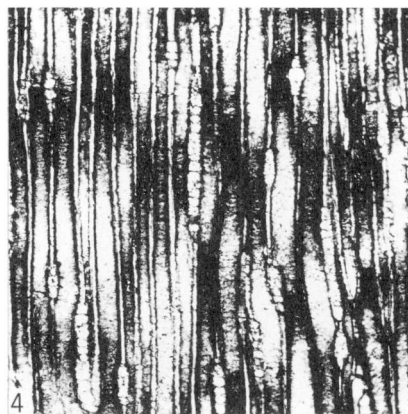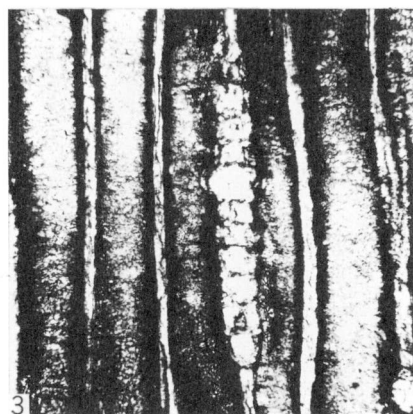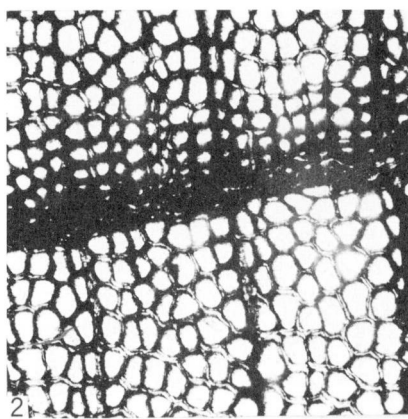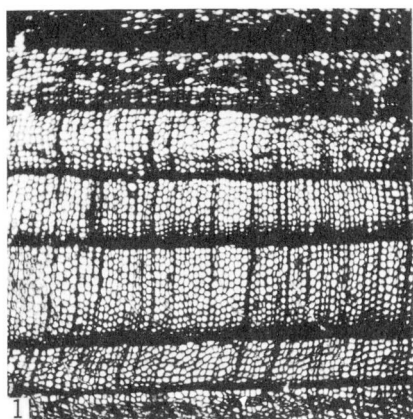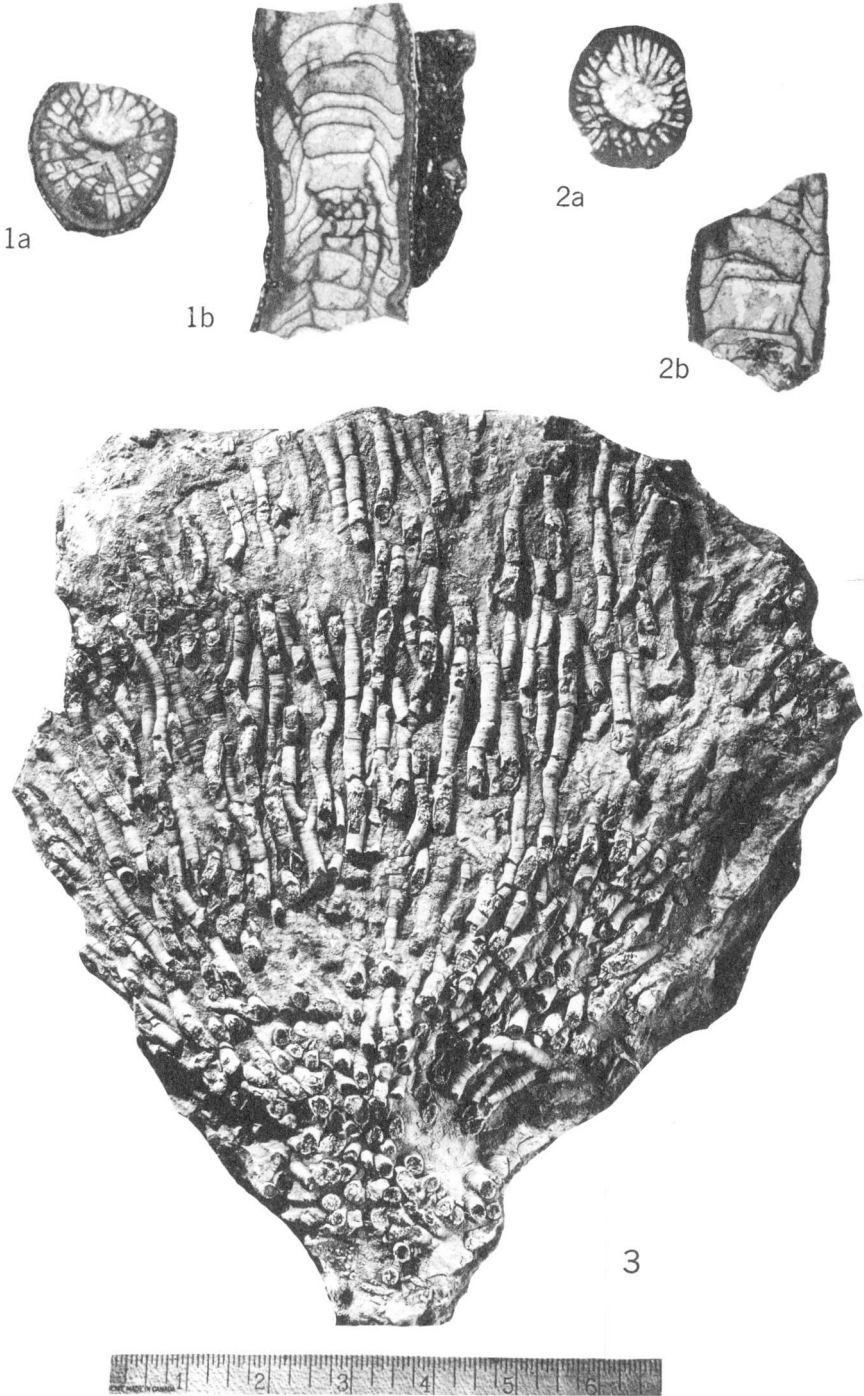
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Figures 1-3. *Synaptophyllum arundinaceum* (Billings). 1a, transverse section of coral-
lite, lectotype G.S.C. No. 3602a; 1b, longitudinal section of same
corallite, lectotype G.S.C. No. 3602b; 2a, transverse section of coral-
lite, lectotype G.S.C. No. 3602c; 2b, longitudinal section of same
corallite, lectotype G.S.C. No. 3602d; 3, side view of corallum, lecto-
type G.S.C. No. 3602, x 0.4. Bois Blanc formation, 3 miles west of
Cayuga, Ontario; collector E. Billings, 1857. (Page 18.)

Figures 1-5. *Synaptophyllum arundinaceum* (Billings). 1a, transverse section of corallite, lectotype G.S.C. No. 3602e; 1b, longitudinal section of same corallite, lectotype G.S.C. No. 3602f; 2a, transverse section of corallite, lectotype G.S.C. No. 3602g; 2b, longitudinal section of same corallite, lectotype G.S.C. No. 3602h; 3a, transverse section of corallite, lectotype G.S.C. No. 3602i; 3b, longitudinal section of same corallite, lectotype G.S.C. No. 3602j; 4a, transverse section of corallite, lectotype G.S.C. No. 3602k; 4b, longitudinal section of same corallite, lectotype G.S.C. No. 3602k. Bois Blanc formation, 3 miles west of Cayuga, Ontario; collector E. Billings, 1857. 5a, transverse section of corallite, syntype G.S.C. No. 3432c; 5b, longitudinal section of same corallite, syntype G.S.C. No. 3432d. Bois Blanc formation, "Walpole tp., Haldimand Co., and Wainfleet tp., Welland Co., Ontario"; collectors Billings and Murray, 1857. (Page 18).

Figure 6 *Acinophyllum simcoense* (Billings). 6a, transverse section of hypotype G.S.C. No. 3436c; 6b, longitudinal section of hypotype G.S.C. No. 3436d. "Corniferous, F.1, near Woodstock, Ontario; collector Murray 1860?" (Page 24).
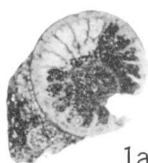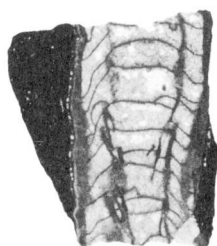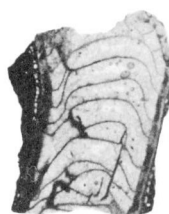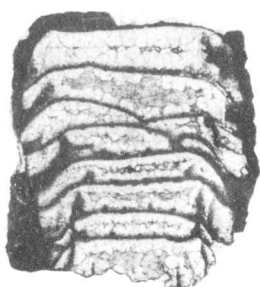
PLATE VIII

1a

1b

2a

2b

3a

3b

4a

4b

5a

5b

6a

6b

PLATE IX

1a

2a

1b

2b

4a

3

4b
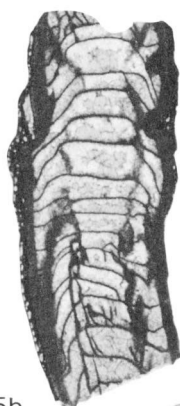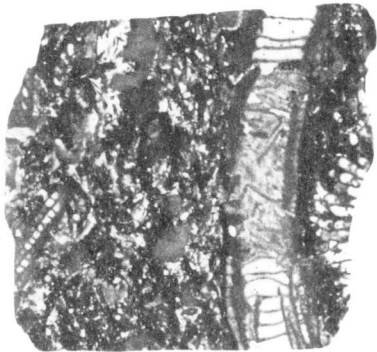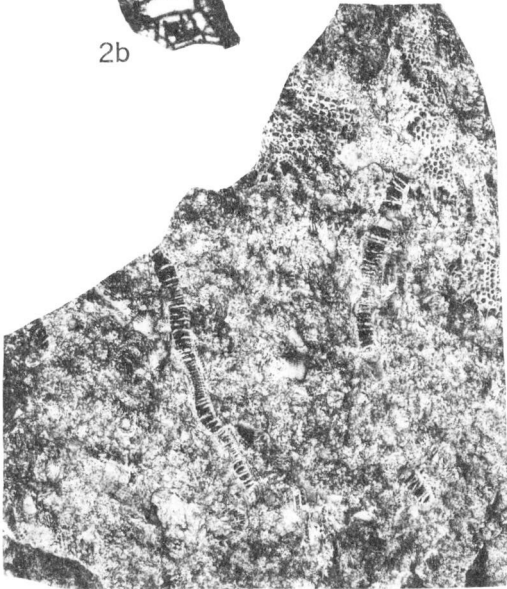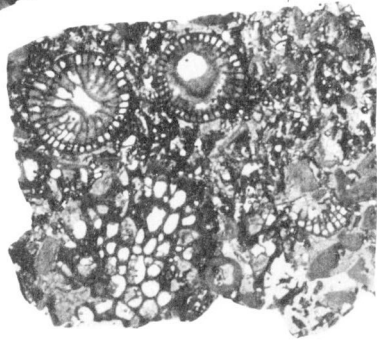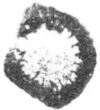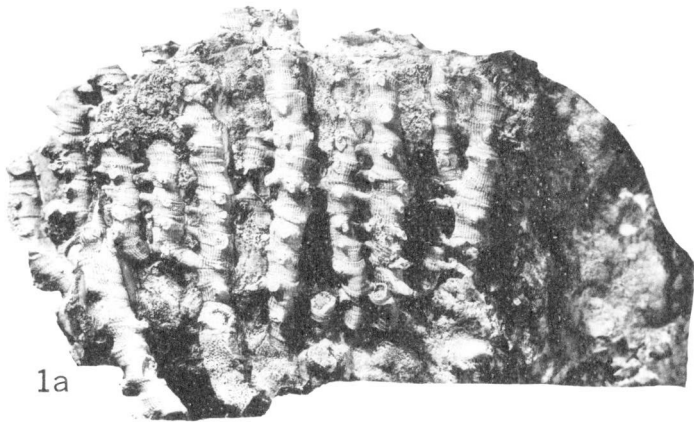
Figures 1, 2. *Acinophyllum simcoense* (Billings). 1a, side view of hypotype G.S.C. No. 3436, natural size; 1b, oblique view of hypotype G.S.C. No. 3436, natural size; 2a, transverse section of corallite, hypotype G.S.C. No. 3436a; 2b, longitudinal section of same corallite, hypotype G.S.C. No. 3436b. "Corniferous, F.1, near Woodstock, Ontario; collector Murray 1860?". (Page 24.)

Figures 3, 4. *Acinophyllum stramineum* (Billings). 3, part of lectotype G.S.C. No. 3431, natural size; 4a, transverse section of lectotype; 4b, longitudinal section of lectotype. Bois Blanc formation, "lot 6, con. 1, Wainfleet, Ontario"; collector E. Billings 1857. (Page 25.)

PLATE X